

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-0000

December 23, 1992



William A. Bonnet  
Manager  
Environmental Department

The Honorable Duke Bainum  
Chairman - House Committee on  
Energy & Environmental Protection  
1208 State Office Tower  
235 South Beretania Street  
Honolulu, HI 96813

Dear Representative Bainum:

HECO is pleased to have the opportunity to brief you and your staff on the EMF issue. The enclosed reference material should be helpful to you and your constituents in understanding what is known about EMF at this time.

Seven items are enclosed:

- (1) A summary of Hawaiian Electric Company's position with regard to EMF.
- (2) A publication produced by Carnegie Mellon University. This was funded by the Electric Power Research Institute (EPRI) and the National Science Foundation (NSF); neither organization reviewed or approved the contents of the brochure. This, in my opinion, adds credibility to the contents of the document.
- (3) A brief summary of the judicial decision in New York related to damage claims for exposure to magnetic fields from electric transmission lines. A determination was made that there is no basis upon which to award damages for alleged reduction in property values related either to adverse health effects or the fear of such effects.
- (4) A copy of the "Department of Health Policy Related to Electromagnetic Fields from Electric Power Lines" (dated 4/3/91), which reinforces Dr. John Lewin's memo of March 16, 1990 to Mr. Edward Hirata, in which Dr. Lewin states, "...no scientific, public health objection to the construction..." of HECO's proposed transmission line from Waiau to Makalapa.

The Honorable Duke Bainum  
December 23, 1992  
Page Two

- (5) A November 1991 executive summary of EMF research data from a study conducted in Los Angeles.
- (6) Summary results of a recent Swedish study, lending support to a possible association between magnetic fields and certain forms of cancer.
- (7) Information from an even more recent Danish study showing no excess risk of leukemia related to magnetic fields.

I hope this information will be useful to you. Please call me at 543-5673 if I can be of further assistance.

Sincerely,



Enc.



Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-000

September 3, 1992



William A. Bonnet  
Manager  
Environmental Department

Dr. Bruce Anderson  
Deputy Director for Environmental Health  
Hawaii State Department of Health  
P. O. Box 3378  
Honolulu, HI 96801-3378

Dear Dr. Anderson:

Subject: EMF

You may recall Leslie Au having made measurements at the Namba residence some time ago. Based on those measurements, Mr. and Mrs. Namba continue their efforts to have the fields reduced by relocation or design modification of the HECO subtransmission and distribution lines fronting their home. A copy of our letter dated April 15, 1992 is enclosed, outlining the engineering alternatives and costs.

As you can see from the enclosed letter dated July 1, 1992, Mr. and Mrs. Namba have begun discussion with the Public Utilities Commission. On August 24, Mrs. Namba invited me to meet with Senator Bert Kobayashi and Councilman Leigh Wai Doo at her home. While cordial, that meeting did not resolve the situation. The more recent letter (August 26) from Dr. Robert Wilkinson urges the PUC to "develop a policy to protect these children and other children from excessive electromagnetic radiation in our community."

I am not sure what basis Dr. Wilkinson may have for his assertion that the measured field strengths in the Namba home are "unusually high" or what his involvement may have been in the recently released information from the Waianae area, to which he refers as "not closed and still controversial."

Because Mr. and Mrs. Namba are enlisting a physician to lend support in their appeal to the PUC, I think it is only a matter of time before the Department of Health is brought back into this case. This letter is not a request for specific action, only an alert that things are happening which will probably involve you. Should you choose to take initiative with all three parties (Namba/Wilkinson/PUC), we would certainly have no problem with that and ask only that you keep us informed.

Sincerely,

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-0

*[Handwritten signature]*

ENV - EMF  
JA/G



William A. Bonnet  
Manager  
Environmental Department

April 15, 1992

Mr. and Mrs. Nolan Namba  
3060 Lakimau Street  
Honolulu, Hawaii 96815

Dear Mr. and Mrs. Namba:

As a follow-up to my letter dated February 20, 1992, our engineers have completed their analysis of possible alternative modifications to the Hawaiian Electric Company's system in your area, with the objective of examining potentially cost-effective means of reducing magnetic field levels. Table #1 summarizes these findings, which I will review one by one:

1. EXISTING CONDITION (A)

Our computer model predicted slightly higher levels than those measured last May by the Department of Health, as reported to you in their letter of August 29, 1991. Given the variety of sources (inside the house as well as outside) and the variability of current flow over time, I believe the computed level correlates reasonably well with the "snapshot" taken by the Department of Health. Our computer model assumes maximum current flow in the distribution lines, which may in part account for predicted fields higher than measured. The three graphics designated "A" (attached) show the existing system configuration with plotted electric and magnetic field strengths.

2. REMOVING THE EXISTING 12KV CIRCUIT (B)

Our first candidate alternative involved relocation of the existing 12 kv overhead distribution line and associated transformer, since these are the system components closest to your lanai. As you see from the table and attached graphics marked "B", removal of the 12 kv system slightly increases magnetic field strength. As you know from material we have sent previously, there is some phase cancellation from a configuration such as presently exists on Lakimau Street. Removal of the 12 kv components removes that small cancelling effect.

Mr. and Mrs. Nolan Namba  
April 15, 1992  
Page 2

3. INSTALLING A 60 FOOT POLE (C)

A second alternative (see graphics marked "C") would be to increase the steel pole height from its existing 45 feet to 60 feet. While our calculations show that some reduction in magnetic field strength would result, a single pole at 60 feet would be in stark aesthetic contrast to the surrounding neighborhood, which is generally characterized as low profile. Existing conditions are consistent with visual concerns in the Diamond Head area, and the economics of reconfiguring the entire area at \$40,000 per pole we do not feel can be justified.

4. UTILIZING THE EXISTING POLE WITH A NEW 46KV CONFIGURATION (D)

A third alternative, attached graphics designated "D", involves phase reconfiguration of the 46 kv system. As you can see from the summary table, this has no beneficial impact on the magnetic field strengths.

5. UNDERGROUNDING THE 46KV SYSTEM

Finally, we examined the effect of undergrounding the 46 kv transmission line fronting your property. Although the computer model was not designed to accommodate these inputs, by separate calculation our engineers have made reasonable design assumptions and compute a magnetic field strength of 26 milligauss at a height of three feet above ground at the location of the line and roughly 4 milligauss at the nearest wall of your residence. At a cost of \$292,000 we are unable to justify this alternative.

6. SHIELDING

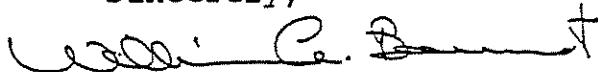
We are unaware of any effective shielding methods, given the physics of magnetic fields. Hence, this does not appear to be an option.



Mr. and Mrs. Nolan Namba  
April 15, 1992  
Page 3

In summary, we are unable to determine any cost-effective engineering mitigation measures for this situation. However, to give perspective to the computed existing 17 milligauss, we may examine the Florida standards. Of the two states which have established edge of right-of-way magnetic field standards for new lines, Florida's is the more stringent at 150 milligauss. Your situation is roughly an order of magnitude below that figure. As Mr. Leslie Au indicated in his previous letter to you, "the interpretation of measurements is very difficult because the scientific evidence is so shaky. The current body of evidence does not scientifically prove that EMF, or magnetic fields in any strength, can cause childhood or adult cancers." I hope you continue to monitor research, as suggested by Mr. Au. If we can help you stay abreast of the latest findings, we would be pleased to do so.

Sincerely,



Enclosures

cc: Senator Bert Kobayashi w/enclosures  
Leslie Au, DOH w/ enclosures

bcc: G. T. Iwahiro w/enclosures  
R. L. O'Connell w/enclosures  
F. Hirakami w/o enclosures  
S. Elliot w/o enclosures



EMF STUDY – 3060 LAKIMAU STREET			
CONDITION	CALCULATED EMF AT LANAI LEVEL (13.28' ABOVE GRADE)		ESTIMATED COST
	ELEC (KV/M)	MAG(mG)	
DEPARTMENT OF HEALTH FIELD MEASUREMENT		11.0 – 5.15	
EXISTING CONDITION (A)	0.98	17.23	
REMOVE EXISTING 12KV CIRCUIT (B)	0.165	18.22	\$46,800
INSTALL 60 FOOT POLE WITH EXISTING LINE CONFIG. (C)	0.065	7.74	\$40,000
UTILIZE EXISTING POLE WITH NEW TRIANGULAR 46KV CIRCUIT CONFIGURATION (D)	0.115	17.68	\$30,000
UNDERGROUNDING OF 46KV CIRCUITS FRONTING 3060 LAKIMAU STREET	(2)	(2)	\$292,000

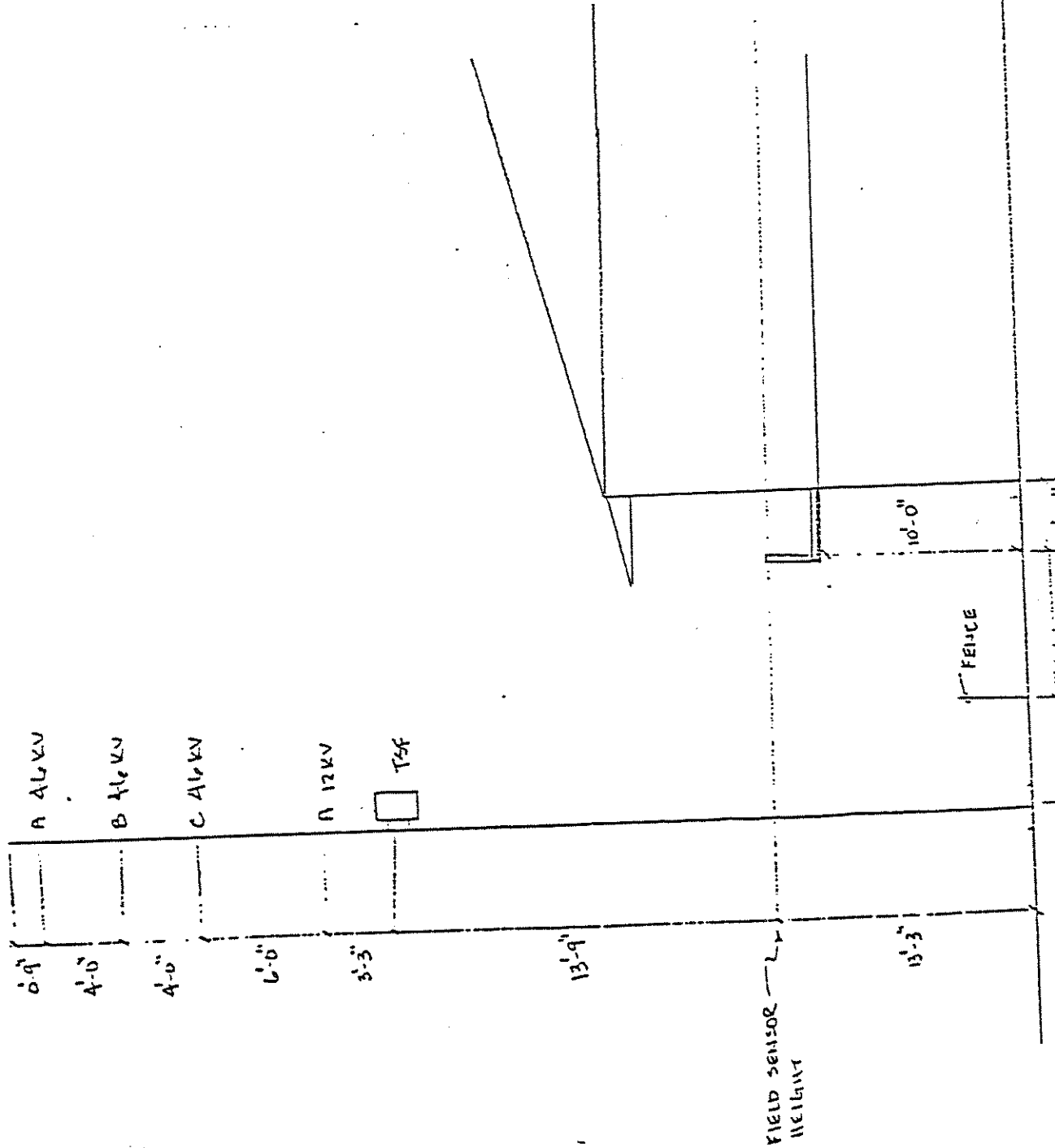
- (1) EMF CALCULATIONS ARE BASED ON PEAK CIRCUIT AMPACITIES OF:  
350A AT 46KV  
5A AT 12KV

- (2) COMPUTER FACILITIES NOT AVAILABLE TO CALCULATE EMF

FEB. 28,1992

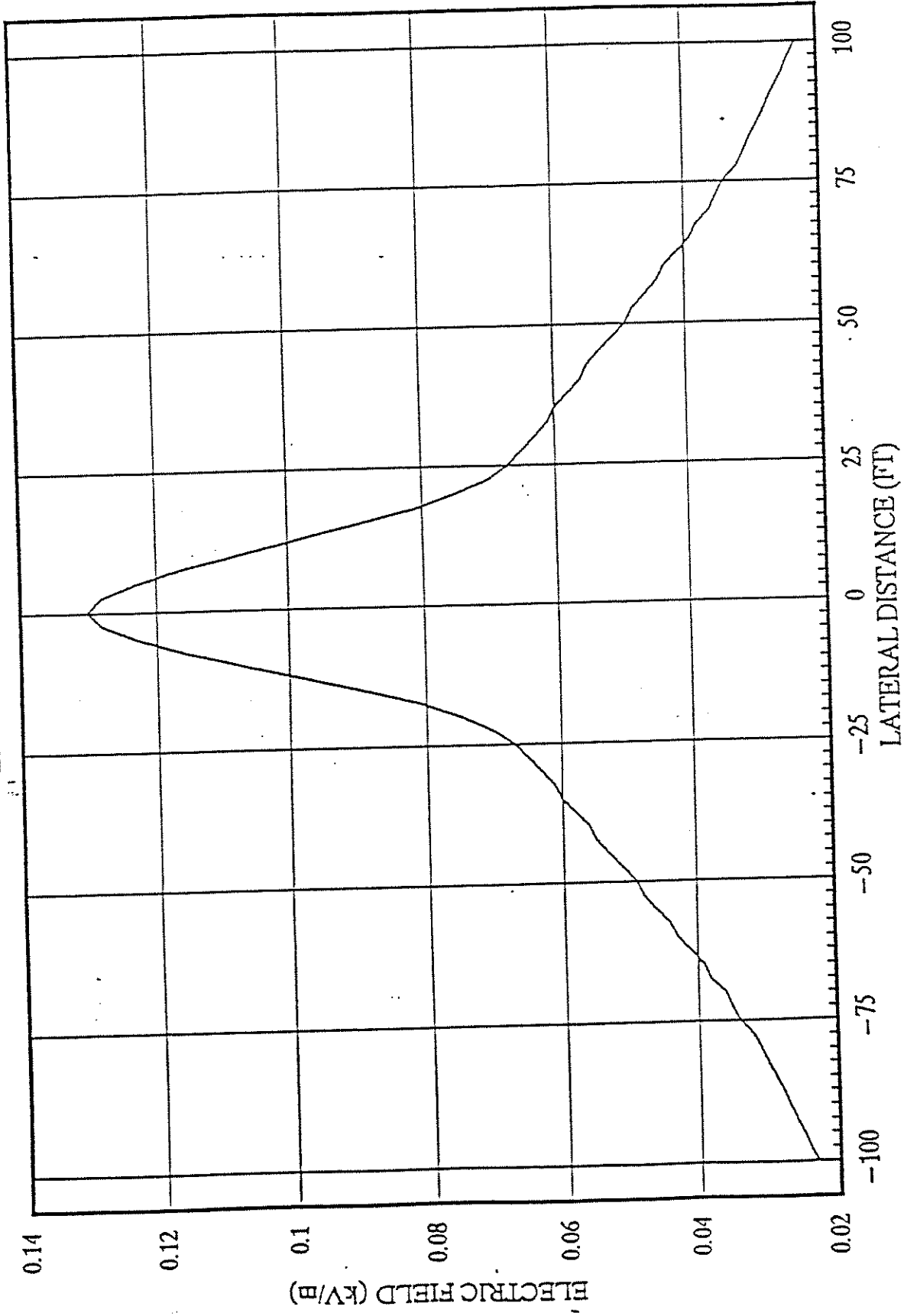
TABLE #1

EXISTING CONDITION (A)



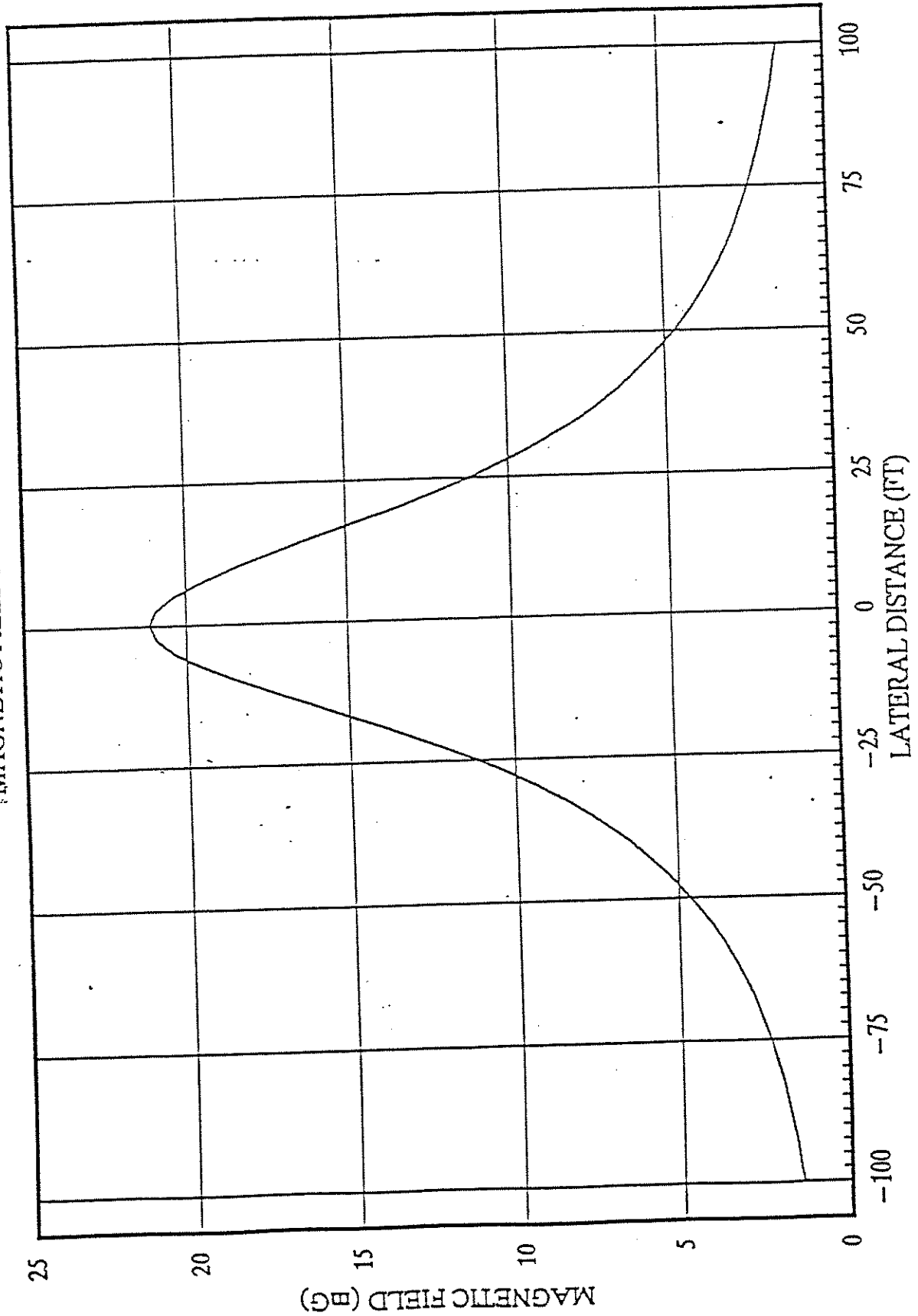


(A) P5 LAKIMAU ST.  
ELECTRIC FIELD PROFILE



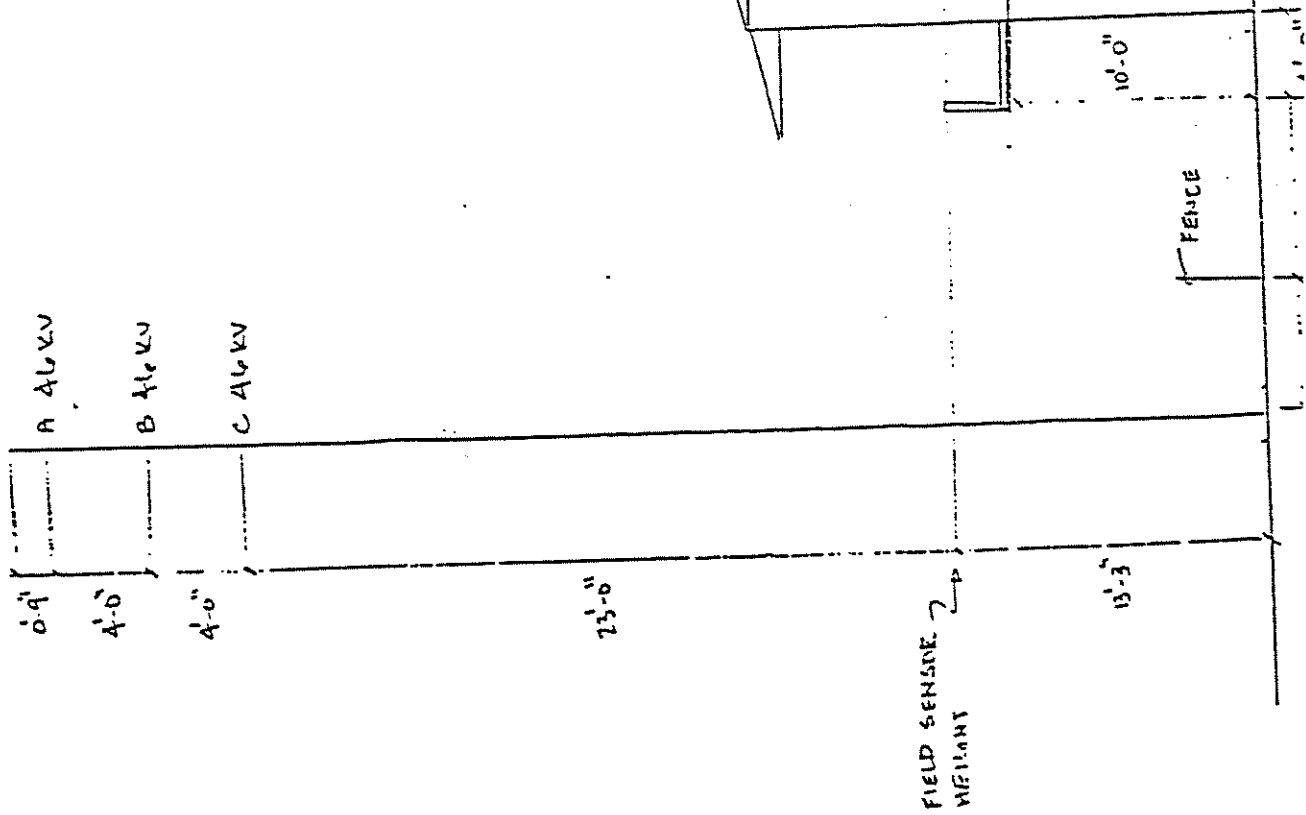
46KV=350A, 12KV=5A  
FIELD SENSOR HEIGHT=13.28' ABOVE GROUND

(A) P5 LAKIMAU ST.  
MAGNETIC FIELD PROFILE

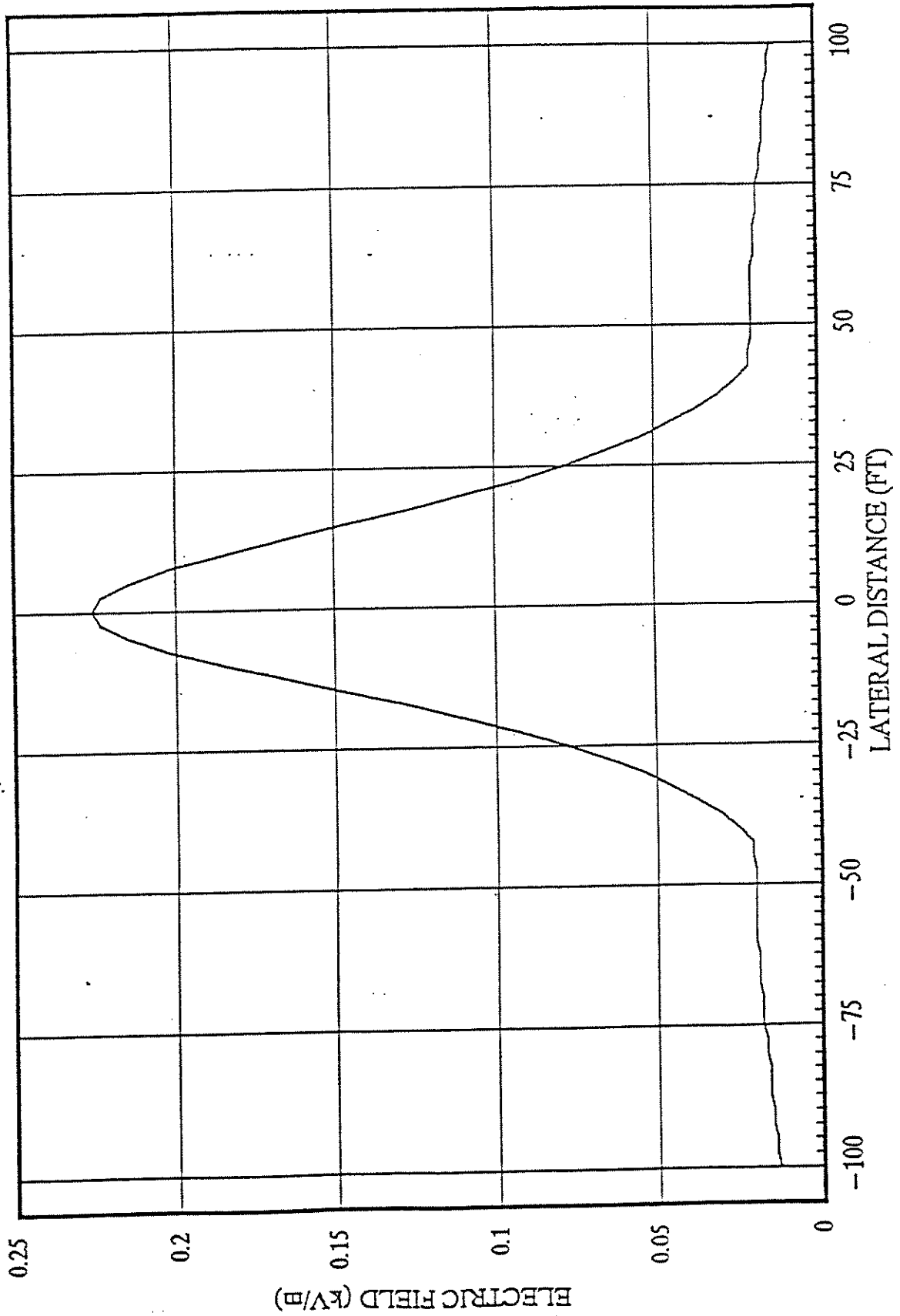


46KV=350A, 12KV=5A  
FIELD SENSOR HEIGHT=13.28' ABOVE GROUND

12KV CIRCUIT REMOVAL (B)

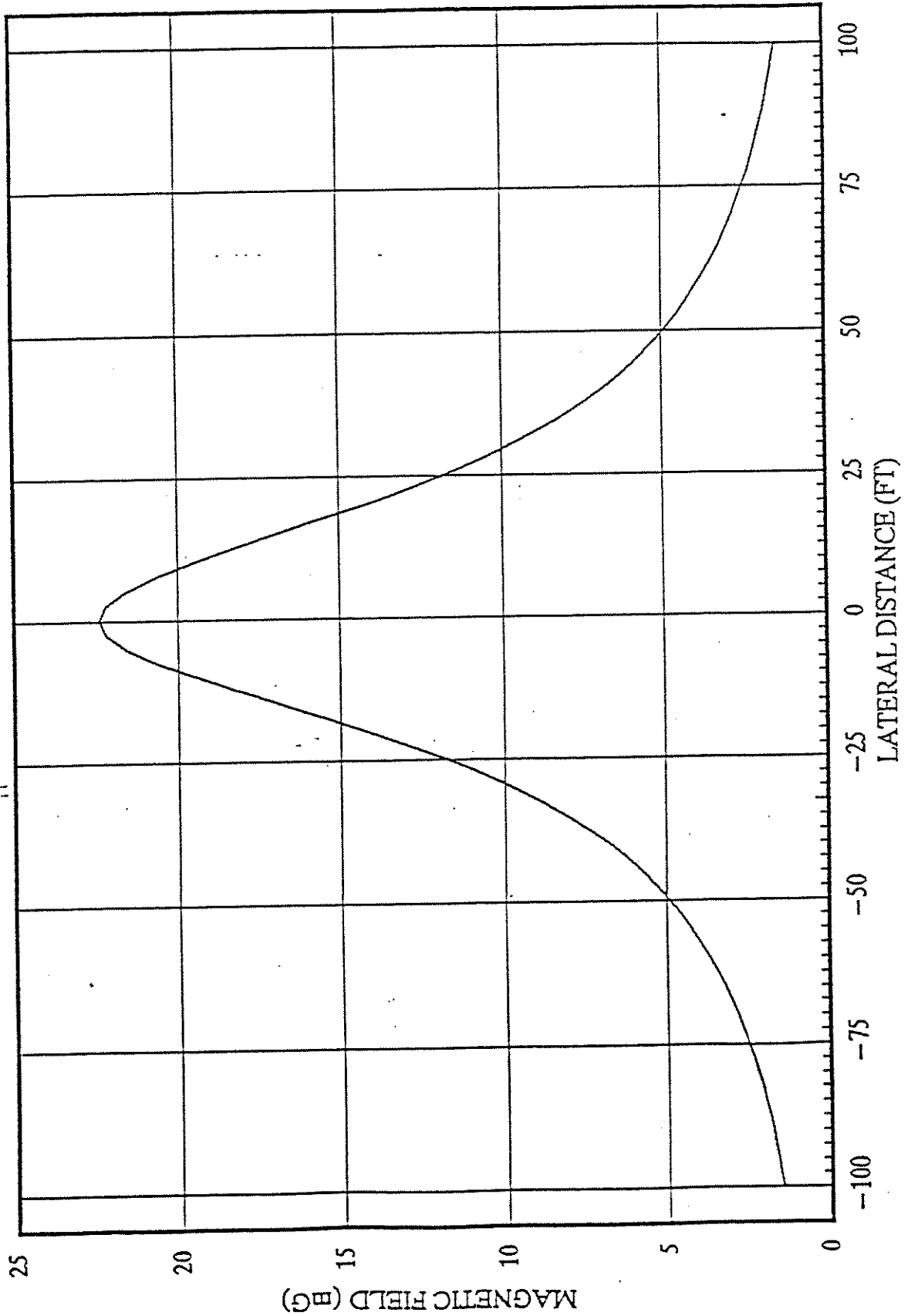


(B) P5 LAKIMAU ST.  
ELECTRIC FIELD PROFILE

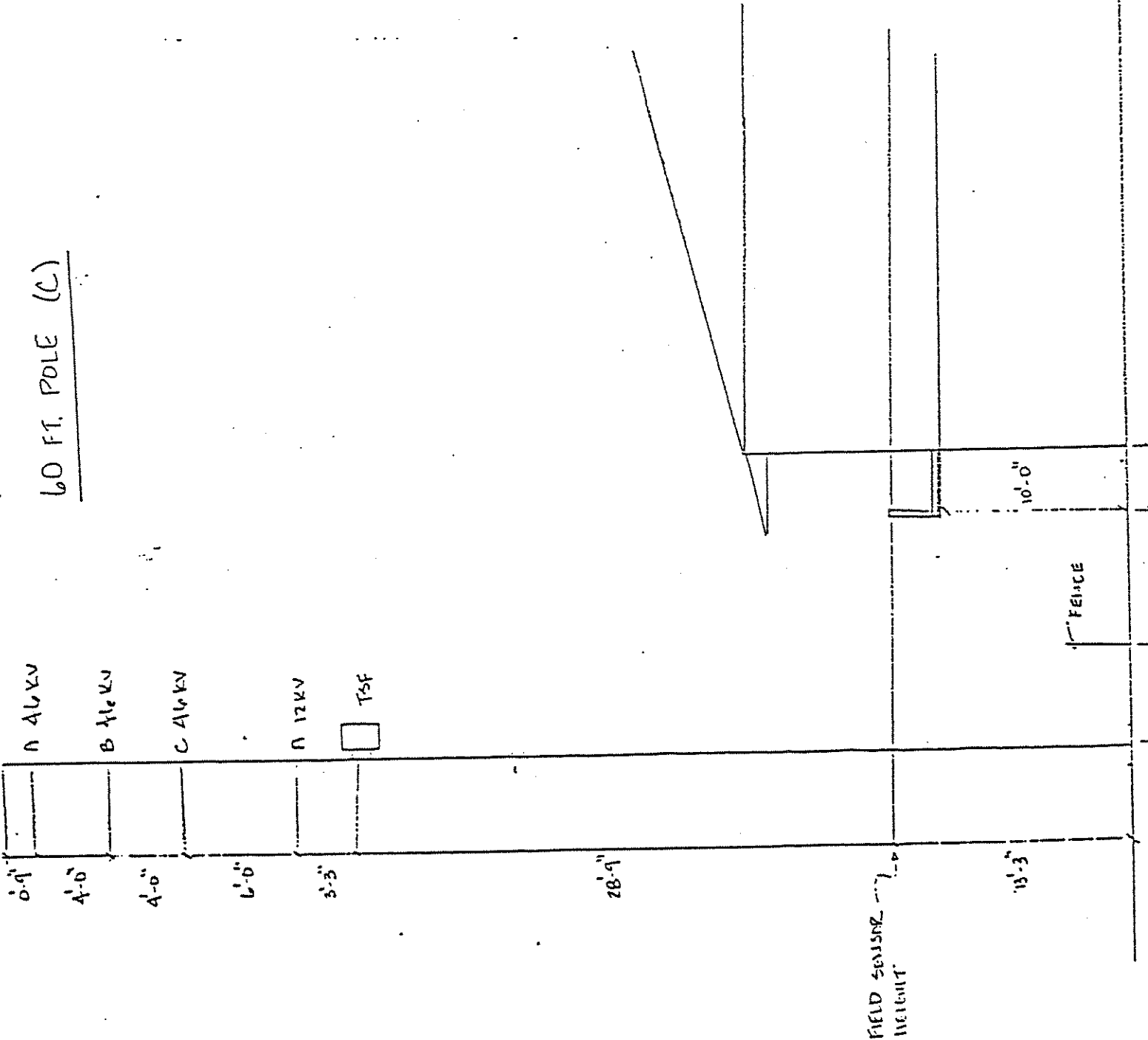


46K=350A, 12KV=5A  
FIELD SENSOR HEIGHT=13.28' ABOVE GROUND

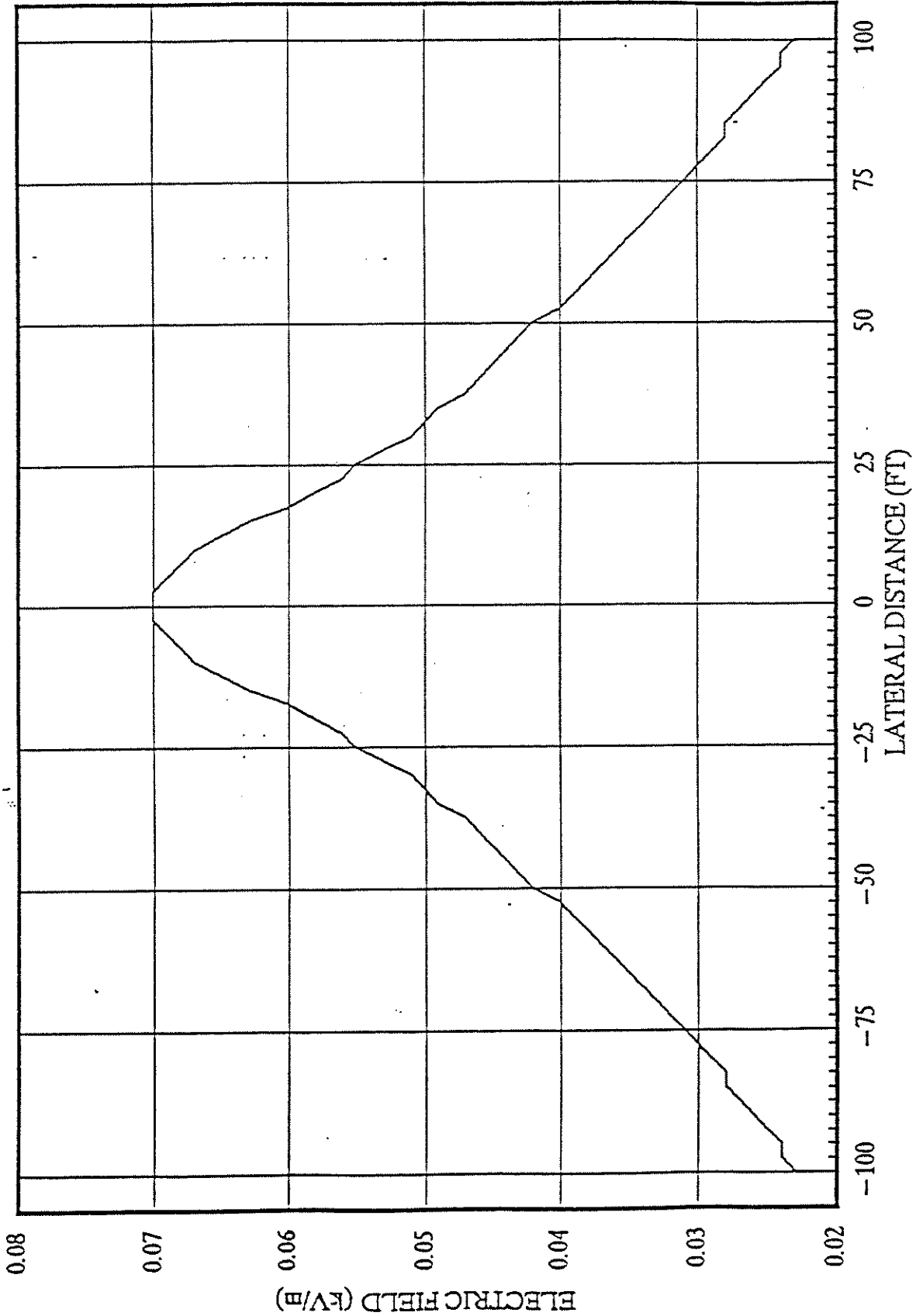
(B) P5 LAKIMAU ST.  
MAGNETIC FIELD PROFILE



46KV=350A, 12KV=5A  
FIELD SENSOR HEIGHT=13.28' ABOVE GROUND

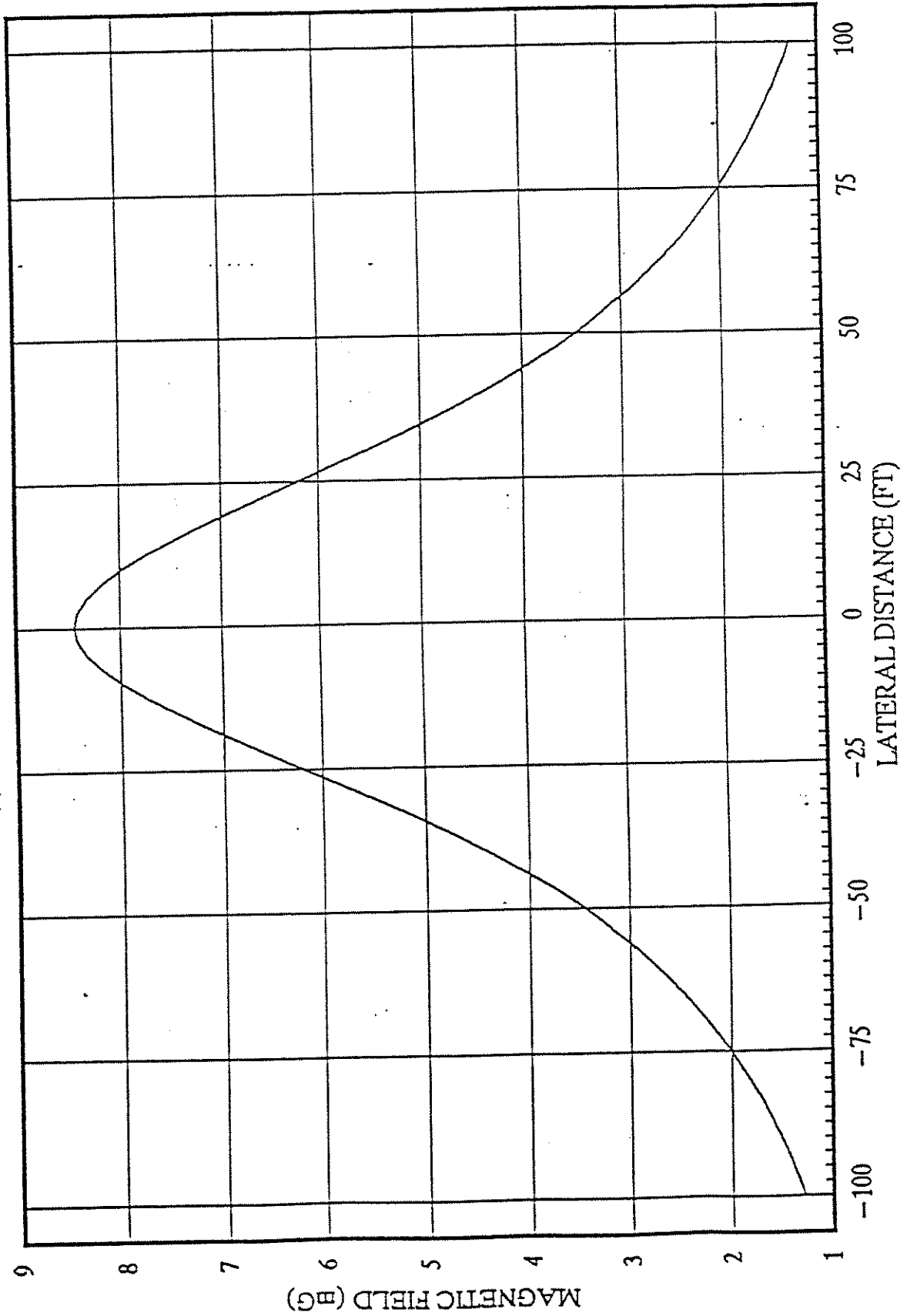


(C) P5 LAKIMAU ST.  
ELECTRIC FIELD PROFILE



46KV=350A, 12KV=5A  
FIELD SENSOR HEIGHT=13.28' ABOVE GROUND

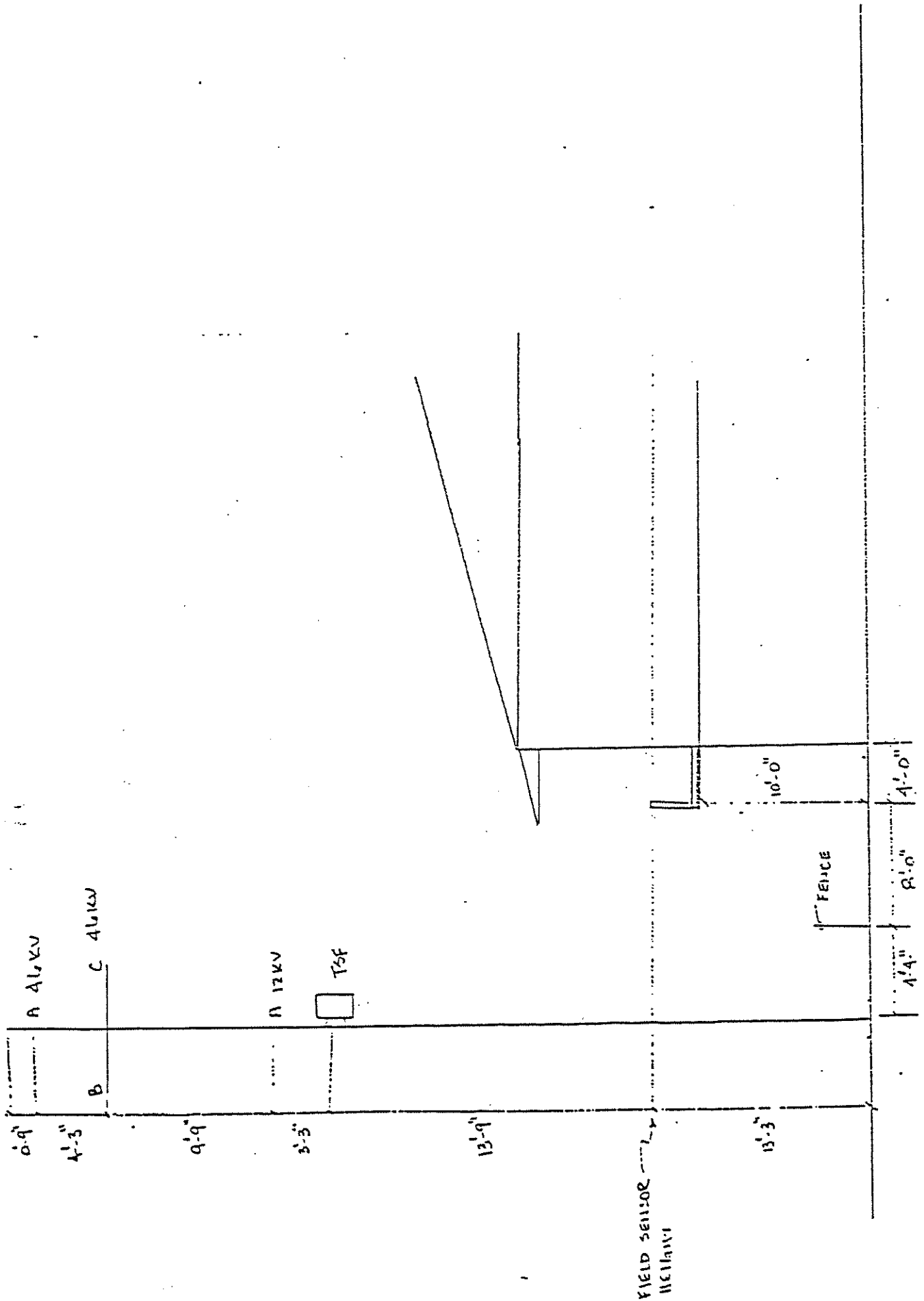
(C) P5 LAKIMAU ST.  
MAGNETIC FIELD PROFILE



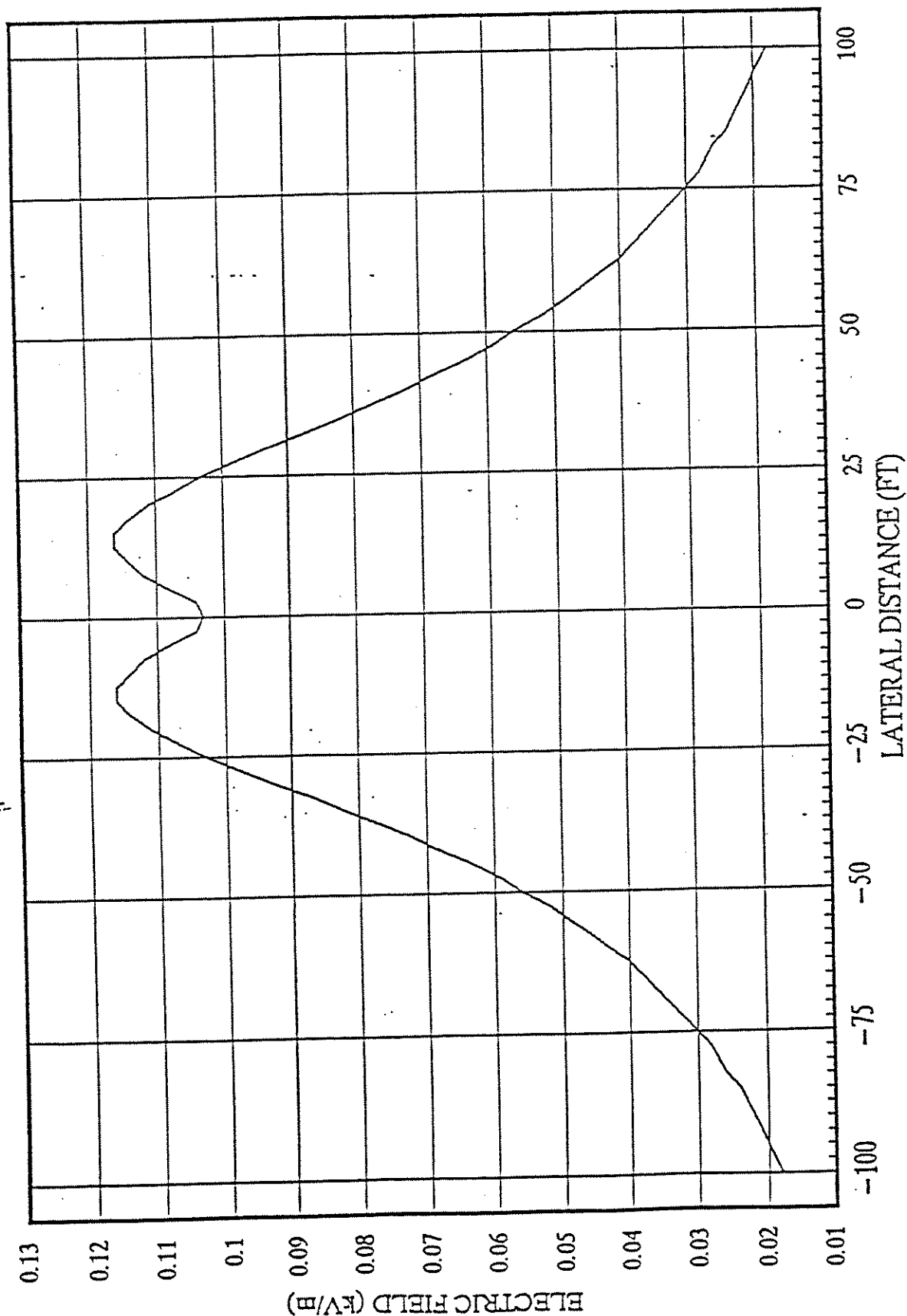
46KV=350A, 12KV=5A  
FIELD SENSOR HEIGHT=13.28' ABOVE GROUND



TRIANGULAR 46KV FRAMING (D)

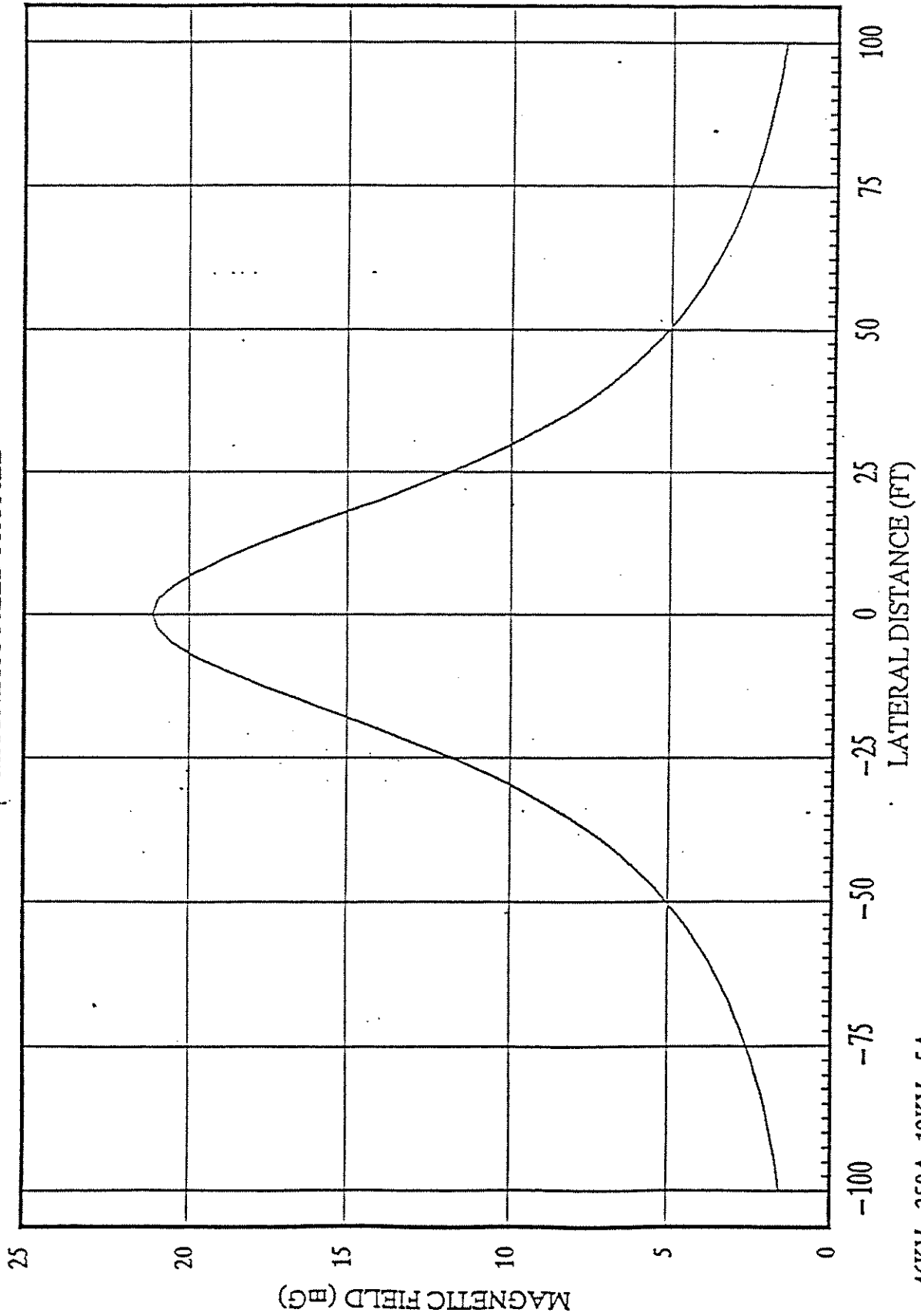


(D) P5 LAKIMAU ST  
ELECTRIC FIELD PROFILE



46KV=350A, 12KV=5A  
FIELD SENSOR HEIGHT=13.28' ABOVE GROUND

(D) P5 LAKIMAU ST.  
MAGNETIC FIELD PROFILE



46KV=350A, 12KV=5A  
FIELD SENSOR HEIGHT=13.28' ABOVE GROUND

7/6/92 Copies to: G. T. Iwahiro  
R. L. O'Connell  
J. M. Erickson  
F. Hirakami  
S. Elliot

July 1, 1992

Mr. Yukio Naito  
Chairman, Public Utilities Commission  
State of Hawaii  
465 S. King Street, Room 103  
Honolulu, Hawaii 96813

Dear Mr. Naito:

Thank you for meeting with us on Monday, June 22nd to discuss our concerns about the high electro-magnetic radiation readings in our home due to the close proximity of a 46,000 volt sub-transmission system. Above all, we are very concerned about the cumulative effects of long term exposure to that electro-magnetic radiation on the health of our four young children.

We appreciate your willingness to speak with the Hawaiian Electric Company to explore additional alternatives beyond those already identified by them to solve this problem in an effective and expeditious manner. To reiterate, we are seeking a solution (or combination of solutions) that brings the level of electro-magnetic radiation in our home to less than 2.0 mG, with the majority of the house at 1.0 mG. As we mentioned, the Department of Health has already documented unusually high readings in our home ranging from 11.0 mG at the point closest to the radiation source to the lowest reading of 2.5 mG at the farthest end of the house. Currently, our children are being exposed to radiation well in excess of 2.0 mG throughout our home.

Experts consider the normal level of electro-magnetic radiation in a house to be no greater than 2.0 mG (Browning, Graeme, "High Voltage Debate", National Journal, August 17, 1991, p. 2030). In Denver, Colorado, half the houses measured had an average electro-magnetic reading below 0.47 mG. Ninety percent of the houses measured fell below 1.82 mG. The San Francisco Bay Area study shows fifty percent of the houses measured to have levels of electro-magnetic radiation below 1.05 mG.

Again, we appreciate your help in exploring all alternatives. We are open to a meeting with Senator Kobayashi, yourself and the Hawaiian Electric Company to discuss new alternatives. Please know that we are not unsympathetic nor ignorant of the business needs of any well-meaning public utility in its mission to serve the collective needs of all of its customers now and in the future.

However, we also firmly believe that our children are, without question, being exposed to a hazardous health environment caused by an atypical power line configuration situated unusually close to our home. We simply could not live with ourselves as parents if we do not pursue every avenue within our power to correct this

LETTER TO MR. YUKIO NAITO - JULY 1, 1992

situation; particularly if any of our children were to be adversely affected in the future. We are very serious about our concern.

There needs to be a balancing point. If at all possible, it is definitely in our nature to preferably seek mutually beneficial solutions in an open and cooperative manner. And it is in this spirit that we will proceed as you suggested and we look forward to hearing from you within the next two months.

Sincerely,

*Cynthia Namba*

*Nolan J. Namba*

Cynthia and Nolan Namba  
3060 Lakimau Street  
Honolulu, Hawaii 96815  
ph. 735-2576

cc: Mr. Bill Bonnet  
Mr. Andrew Chang  
Senator Bert Kobayashi

PATSY T. MINK  
SECOND DISTRICT, HAWAII

WASHINGTON OFFICE:  
2135 RAYBURN HOUSE OFFICE BUILDING  
WASHINGTON, DC 20515-1102  
(202) 225-4908  
FAX (202) 225-4987

DISTRICT OFFICE:  
5104 PRINCE KUNIG FEDERAL BUILDING  
P.O. Box 50124  
HONOLULU, HAWAII 96850-4977  
(808) 541-1988  
FAX (808) 538-0233

Congress of the United States  
House of Representatives  
Washington, DC 20515-1102

COMMITTEE ON EDUCATION AND LABOR  
SUBCOMMITTEES:  
ELEMENTARY, SECONDARY & VOCATIONAL EDUCATION  
POSTSECONDARY EDUCATION  
LABOR-MANAGEMENT RELATIONS  
COMMITTEE ON GOVERNMENT OPERATIONS  
SUBCOMMITTEES:  
HUMAN RESOURCES AND INTERGOVERNMENTAL RELATIONS  
GOVERNMENT INFORMATION, JUSTICE AND AGRICULTURE

September 1, 1992

Mr. Paul Luersen, AICP  
Senior Project Manager  
CH2M HILL - Honolulu Office  
1585 Kapiolani Boulevard  
Suite 1312  
Honolulu, HI 96814

Dear Mr. Luersen:

Thank you for affording me an opportunity to comment on the scope of analysis for the Environmental Assessment (EA) to be prepared in connection with the construction and operation of two 138 kV transmission lines to interconnect the Campbell Industrial Park Substation and the planned Ewa Nui Substation in the Ewa District, Oahu.

I suggest that it would be very much in the public interest for the EA to include the following matters:

(1) An explanation as to how a reliable EA can be made with reference to the 1,100 acres of State-owned land before the master plan for that tract has been completed by the Hawaii Housing Finance and Development Corporation. I suggest that it is imperative that there be accurate knowledge of the infrastructure to be developed, and the locations of the many homes to be constructed on the tract before a realistic EA can be made.

(2) An explanation as to how the April 3, 1991 Hawaii Department of Health policy relating to electromagnetic fields from electric power lines will be implemented. I understand the essence of this policy is that a "prudent approach" should be taken in siting new facilities, meaning that where technically feasible and practical, public exposure should be minimized.

(3) A full and detailed discussion of what were termed "Unresolved Issues" in HECO's Draft Environmental Impact Statement for Part 2 of the Waiiau-Campbell Industrial Park 138 kV Transmission Line Project, namely: the issue of public health effects from electric and magnetic fields and the question of social equity as it relates to both the neighborhood directly affected by the transmission lines and poles, and to the community at large. (See Draft EIS, p. 1-6.)

(4) A complete explanation of HECO's established policy and practice governing when power lines will be put underground and the associated costs passed on to the utility's rate payers.

(5) At the public hearing on February 4, 1992 on Part 2 of the Waiiau-Campbell Industrial Park 138 kV Transmission Line Project, a spokesman for HECO stated, "... we leave the responsibility of determining health impacts to the State Department of Health as they are better equipped to evaluate this potential." (See HECO's "Notes" of said meeting which were distributed to the public, p. 7.) The EA should contain a full and detailed explanation as to how coordination is effected between HECO and the Department of Health, including a written commitment from the Department of Health as to its role and responsibilities on this problem, in order that an adequate evaluation may be made of the sufficiency of this approach to such a critically important question which so gravely affects the welfare of the public.

(6) A detailed statement of the expected electric and magnetic fields should be provided, together with an explanation as to how the accuracy of such calculations will be determined. This should include a statement as to whether HECO intends to do pre-construction testing and post-construction testing. If such testing is not to be made, a full explanation should be included. If such testing is to be conducted, a full explanation of when, where and how should be given. It should also be established how the public will be able to determine the reliability of such testing and what recourse the public will have if the testing shows that corrective action is necessary.

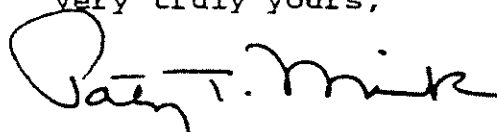
(7) There should be a full explanation of all recommendations made by consultants relating to reducing the impacts of electric and magnetic fields. This should be accompanied by a statement as to which of the recommendations are being implemented and an explanation as to why the other recommendations are being rejected.

(8) A full explanation as to the cumulative impacts of electric and magnetic fields when referenced future improvements are made to the system. This is especially needed in connection with the new Ewa Nui Substation and the transmission lines after that substation has been improved.

(9) An explanation of the status of the development of super conductor transmission lines for high voltage electrical lines.

Again, thank you for the opportunity to submit these comments. I trust that you will carefully consider them in preparing the EA.

Very truly yours,

A handwritten signature in dark ink, appearing to read "Patsy T. Mink". The signature is fluid and cursive, with the first name "Patsy" being more prominent.

PATSY T. MINK  
Member of Congress

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-0001 • Phone: (808) 543-7333 • FAX: (808) 543-7898



George T. Iwahiro  
Vice President  
Engineering

April 28, 1992

The Honorable Patsy T. Mink  
Member of Congress  
U. S. House of Representatives  
2135 Rayburn House Office Building  
Washington, D.C. 20515-1102

Subject: Waiau-Campbell Industrial Park 138 kV, Part 2,  
Transmission Line Project

Dear Congresswoman Mink:

We are in receipt of your March 25, 1992 letter on the subject of our proposed Waiau-Campbell Industrial Park (CIP) 138 kV, Part 2, Transmission Line Project in which you request information on a number of items related to electric and magnetic fields (EMF) to assist you in your review of the project's Draft Environmental Impact Statement (DEIS).

As clarification, Section 5.C. of the project's DEIS document is entitled "Electric and Magnetic Field Effects" and addresses this issue in detail (reference pages 5-27 through 5-50). The document was mailed on April 8, 1992 to those on the distribution list approved by the Office of Environmental Quality Control, including Mr. Chuck Keever of your local Honolulu office.

Please note as well that Hawaiian Electric Company, Inc. (HECO) has been working since 1987 to find the least objectionable southern route (separate from the existing mauka transmission line corridor) for these transmission lines, per recommendation of our consultant, Stone and Webster. The alignment currently recommended by HECO is the result of four years of analysis of alternative routes and many meetings with community groups and government agencies.

The following is in response to the requests for information detailed in your letter:



1. HECO statement: "...we leave the responsibility of determining health impacts to the State Department of Health as they are better equipped to evaluate this potential." (Notes p. 7)

Request: What coordination has been effected to ensure that HECO and DOH are working together on this matter?

HECO and the Department of Health confer on the subject of EMF in general and on a project basis. It is not uncommon for HECO to refer customers to the Department of Health when concerns are expressed over potential health effects of power frequency fields. Dr. Bruce Anderson (Ph.D. epidemiologist) and Mr. Leslie Au (toxicologist) are particularly well qualified to respond to these inquiries. Conversely, through its memberships in the Electric Power Research Institute (EPRI) and Edison Electric Institute (EEI), HECO is well positioned to stay abreast of national and international development in the EMF area, including, but not limited to, the latest research results. We make it a point to insure that the Department of Health has access to this information.

On a project basis, the Department of Health is a consulted agency on the environmental assessment prepared for each proposed transmission line project. We actively seek their opinion on the potential health implications of our projects, and they respond as a matter of public record. We have found the Department of Health to be knowledgeable and responsive on this subject.

In conjunction with a public meeting for another HECO project--the Waiau-Makalapa No. 2 138 kV transmission line--which was held on April 4, 1991 and hosted by Council Chair Arnold Morgado, the Department of Health on April 3, 1991 issued a policy relating to electromagnetic fields from electric power lines. This policy is included in the Waiau-CIP Part 2 Routing Report on page 9-62 (a copy of which has been forwarded to your local office), and on page 5-43 of the DEIS.

2. HECO statement: "Expected fields will be identified and compared to other uses that generate similar fields." (Notes, p. 7)

Request:

- (a) What is meant by "expected fields?"
- (b) By whom and when will the expected fields be determined?
- (c) What "other uses that will generate similar fields" will be used in this process?
- (d) Will the public be given an opportunity to have HECO's plans in this regard checked by outside experts and to provide input prior to the final decisions being made?



Before the project is constructed, field strengths resulting from the project must, of necessity, be determined by calculation. The computer programs used for this purpose have been applied extensively on the mainland as well as in Hawaii, and predicted levels have been validated against measured levels.

These calculations, or "expected fields", have been made for HECO by J. Michael Silva, president of Eneritech Consultants. Results are set forth in the Waiau-CIP Part 2 Routing Report, Section 9.9 and Appendix D. They also appear in the Draft EIS, Section 5.C.

As a frame of reference for the predicted field strengths, Eneritech Consultants has included tables which show typical field strengths from household and office appliances. This enables the public to examine results in the context of their daily routine, be it home or business. Tables 9.9-1 through 9.9-3 of the Routing Report contain this information; it is also provided in the Draft EIS, in Tables 5-1 through 5-3.

The project Routing Report with the indicated EMF information was submitted to the Public Utilities Commission with the project application for approval of expenditure of funds over \$500,000 on March 12, 1992, and as such is public record. As mentioned above, the Draft EIS, with its extensive section on EMF, was distributed on April 8, 1992 for the 45-day public comment period (including to the Department of Health).

3. HECO statement: {Re. comparing Lualualei and power lines}  
"Studies are on-going." (Notes, p. 7)

Request:

- (a) What studies are on-going; by whom?
- (b) Are any of the documents relating to these studies available to the public; if not, when will they be made available?

On April 2, 1992 contact was made with Mr. Leslie Au of the Department of Health regarding the Lualualei study. The following is a summary of that conversation.

A research paper published about two years ago by Dr. Robert Wilkinson, a University of Hawaii professor, reported clusters of childhood leukemia in three Oahu areas, including Maili-Nanakuli and Waianae. Dr. Robert Worth of the Department of Health reviewed this study and concluded that evidence was inadequate to identify childhood leukemia clusters in these areas. Because of the publicity surrounding reports of Wilkinson's findings, U.S. Environmental Protection Agency Radiation Branch personnel from their Las Vegas office conducted both electric and magnetic field measurements near the



Lualualei transmitting towers. Results have not been released to the Department of Health. It must be noted that the investigation focuses on radio frequency transmissions, in the 10,000 Hz to 5,000,000,000 Hz range, as opposed to power frequency fields at a significantly lower 60 Hz.

We have requested that the Department of Health share results of this study with us as soon as they are released.

4. HECO statement: {Re. comparing Lualualei and power lines} "Consultants have made recommendations on how to limit EMF from power lines which we will follow...HECO has accepted all of the consultant's recommendations." (Notes, p. 7)

Request:

- (a) What are the recommendations which have been made which HECO has decided to follow?  
(b) Are copies of the recommendations available to the public? If not, when will they be made available?

Recommendations on EMF mitigation for this project have been made by Enertech Consultants. These are discussed in Section 9.9 of the Waiau-CIP Part 2 Routing Report and are also included in Chapter 5.C. of the Draft EIS (issued on April 8, 1992 for public review and comment).

5. HECO statement: {Re. comparing Lualualei and power lines} "These recommendations will result in EMF levels five times less than the current Florida standards..." (Notes, p. 7)

Request:

- (a) What are the Florida standards?  
(b) What is the significance of the Florida standards?

Only Florida and New York have right-of-way standards for magnetic field strength. Because Florida has specifically identified standards for voltage below 230 kV (HECO's highest voltage is 138 kV), we generally reference Florida. Note that both Florida and New York, in setting standards, have acknowledged no health-based foundation for these numbers. Florida limits magnetic fields at the edge of right-of-way to 150 milligauss for lines at or below 230 kV. Note that the Department of Health in their policy statement dated April 3, 1991 indicated "too little is presently known to be able to determine where or what rules would provide public health protection."

The intent of the adopted right-of-way standards for magnetic field strengths is to avoid any increase in EMF to levels greater than present levels.

6. HECO statement: "...we are looking at that issue {i.e., cumulative impacts}." (Notes, p. 7)



Request:

- (a) At what locations is HECO currently looking at this issue.
- (b) Please provide the results of the studies made to date.

Mr. Mike Silva of Enertech Consultants measured magnetic fields at locations along the proposed route which past studies suggest might be of greatest interest, e.g. stores, offices (reference Table 9.9-3 in the Waiiau-CIP Part 2 Routing Report). This establishes existing conditions. To show the cumulative result of the proposed transmission lines, both the existing and proposed lines will have to be modeled. Much as is the case with noise levels, the numbers are not directly additive.

- 7. HECO statement: {Re. testing EMF to determine if operations are within the range of calculations.} "Department of Health has this kind of information available." (Notes, pp.7-8)

Request: Who in the Department of Health has this information?

The Department of Health has access to equipment capable of measuring magnetic fields. Specifically, Mr. Leslie Au may be contacted at 586-4249 to request field measurements. Caution must be exercised in comparing measured and computer modeled results. Measurements do not discriminate as to the source. Near a residence, for example, there may be numerous sources, including appliances, contributing to the fields. In contrast, the modeled results are quite specific with respect to source.

- 8. HECO statement: "HECO will commit to the community to select sites along the project route, do pre-test, post-test (after line is built)--information gained will be made public. (Notes, p. 8)

Request:

- (a) When and by whom will this site selection be made?
- (b) Will the public have an opportunity to have independent experts review the details of this proposed testing prior to the tests commencing?
- (c) For how long will these tests be made?
- (d) When will the information be made public?
- (e) What opportunity will the public have to participate in the review and analysis of this testing?
- (f) What security will be provided to ensure that there will be sufficient funds to keep the testing program going?

We state on page 5-31 of the DEIS: "HECO proposes to conduct such a {load flow} study to determine optimum phasing and to make magnetic field measurements at locations selected in



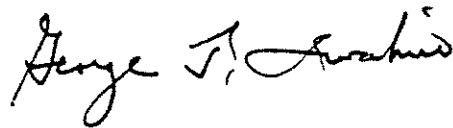
consultation with community representatives, before and after the lines are operating, to compare calculated levels with actual magnetic field levels." Once the transmission line alignment is finalized, surveys are completed, and pole locations are set, HECO plans to work with the Pearl City and Waipahu Neighborhood Boards to select six testing sites (at the mid-point between two poles where the conductor sag is greatest) to represent the six typical pole configurations identified in Table 5-5 in the DEIS. Pre-construction and post-construction magnetic field measurements will be taken at the right-of-way of each selected site.

At the completion of the magnetic field measurement program, the information will be presented to the Pearl City and Waipahu Neighborhood Boards. Ongoing testing is not required.

Please note that as the existing research data on electric and magnetic fields are inconclusive, no convincing and consistent relationship between exposure to EMF and adverse health effects has been demonstrated.

We would be happy to meet with you to discuss further details related to the above questions, and would welcome the opportunity to brief you and your staff on the EMF issue in greater depth. Please contact our Project Manager, Mary Ellen Nordyke-Grace, at 543-7876 to arrange such a meeting, or for further information on the Waiau-CIP Part 2 project.

Sincerely,



cc.: Dr. Bruce Anderson, Hawaii State Department of Health  
Mr. Leslie Au, Hawaii State Department of Health



PATSY T. MINK  
SECOND DISTRICT, HAWAII

WASHINGTON OFFICE:  
2135 RAYBURN HOUSE OFFICE BUILDING  
WASHINGTON, DC 20515-1102  
(202) 225-4908  
FAX (202) 225-4987

DISTRICT OFFICE:  
5104 PRINCE KUHIO FEDERAL BUILDING  
P.O. Box 50124  
HONOLULU, HAWAII 96850-4977  
(808) 541-1986  
FAX (808) 538-0233

**Congress of the United States  
House of Representatives**

Washington, DC 20515-1102

March 25, 1992

COMMITTEE ON EDUCATION AND LABOR

SUBCOMMITTEES:

ELEMENTARY, SECONDARY & VOCATIONAL EDUCATION  
POSTSECONDARY EDUCATION  
LABOR-MANAGEMENT RELATIONS

COMMITTEE ON GOVERNMENT OPERATIONS

SUBCOMMITTEES:

HUMAN RESOURCES AND INTERGOVERNMENTAL RELATIONS  
GOVERNMENT INFORMATION, JUSTICE AND AGRICULTURE

Mr. George Iwahiro  
Vice-President For Engineering  
Hawaiian Electric Company, Inc  
P.O. Box 2750  
Honolulu, Hawaii 96840

Dear Mr. Iwahiro:

Thank you for having added my name to the list of those who will receive a copy of the Draft EIS on the Waiiau-Campbell Industrial Park 138 kV Transmission Lines, Part 2 as soon as it has been completed.

I am very concerned about the deleterious impact on health of the electric and magnetic fields (EMF) generated by these transmission lines. I had a member of my staff attend the public meeting which was held on February 4, 1992 on this subject. As a result of the discussions at that meeting, I had understood that the subject of the potentially deleterious impacts on health of EMF would be fully covered in your draft EIS. This was based upon the fact that there was a substantial discussion of the EMF problem at this meeting, including a commitment by HECO to the community to do pre- and post-construction testing on the impact of EMF.

I note that that in the section of notes prepared after the meeting by your facilitator that the EMF problem is not specifically included in the section labeled, "EIS: What Needs to be Addressed." I trust that the failure specifically to include the EMF problem in the last section of notes results only from the formatting of those notes. Please be advised that I shall be demanding that this problem be fully covered in the Draft EIS.

To facilitate my review of the Draft EIS, I should appreciate your providing me the following information on matters which were discussed at the public meeting.

(1) HECO statement: "... we leave the responsibility of determining health impacts to the State Department of Health as they are better equipped to evaluate this potential." (Notes, P. 7)

Request: What coordination has been effected to ensure that HECO and DOH are working together on this matter?

Mr. George Iwahiro  
March 25, 1992  
Page 2

(2) HECO statement: "Expected fields will be identified and compared to other uses that generate similar fields." (Notes, p. 7)

Request: (a) What is meant by "[e]xpected fields?"  
(b) By whom and when will the expected fields be determined?  
(c) What "other uses that will generate similar fields" will be used in this process?  
(d) Will the public be given an opportunity to have HECO's plans in this regard checked by outside experts and to provide input prior to the final decisions being made?

(3) HECO statement: [Re comparing Lualualei and power lines] "Studies are on-going." (Notes, p. 7)

Request: (a) What studies are on-going; by whom?  
(b) Are any of the documents relating to these studies available to the public; if not, when will they be made available?

(3.1)

(3) HECO statement: [Re comparing Lualualei and power lines] "Consultants have made recommendations on how to limit EMF from power lines which we will follow. ... HECO has accepted all of the consultant's recommendations." (Notes, p. 7)

Request: (a) What are the recommendations which have been made which HECO has decided to follow?  
(b) Are copies of the recommendations available to the public? If not, when will they be made available?

(4) HECO statement: [Re comparing Lualualei and power lines] "These recommendations will result in EMF levels five times less than the current Florida standards ..." (Notes, p. 7)

Request: (a) What are the Florida standards?  
(b) What is the significance of the Florida standards?

(5) HECO statement: "... we are looking at that issue [i.e., cumulative impacts]." (Notes, p. 7)

Request: (a) At what locations is HECO currently looking at this issue.  
(b) Please provide the results of the studies made to date.

Mr. George Iwahiro  
March 25, 1992  
Page 3

(6) HECO statement: [Re testing EMF to determine if operations are within the range of calculations.] "Department of Health has this kind of information available." (Notes, pp. 7-8)

Request: Who in Department of Health has this information?

(7) HECO statement: "HECO will commit to the community to select sites along the project route, do pre-test, post-test (after line is built)--information gained will be made public. (Notes, p. 8)

Request: (a) When and by whom will this site selection be made?

(b) Will the public have an opportunity to have independent experts review the details of this proposed testing prior to the tests commencing?

(c) For how long will these tests be made?

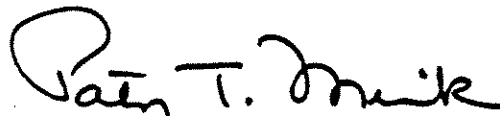
(d) When will the information be made public?

(e) What opportunity will the public have to participate in the review and analysis of this testing?

(f) What security will be provided to ensure that there will be sufficient funds to keep the testing program going?

I shall appreciate your response to my inquiries in this letter.

Very truly yours,

  
PATSY T. MINK  
Member of Congress



RICHARD S. H. WONG  
PRESIDENT

JAMES AKI  
VICE-PRESIDENT

GERALD T. HAGINO  
MAJORITY LEADER

MALAMA SOLOMON  
MAJORITY FLOOR LEADER

BERTRAND KOBAYASHI  
MAJORITY POLICY LEADER

ANDREW LEVIN  
MAJORITY CAUCUS LEADER

RANDY IWASE  
MAJORITY WHIP

MARY GEORGE  
MINORITY LEADER

RICK REED  
MINORITY FLOOR LEADER

FIRST DISTRICT  
ANDREW LEVIN

SECOND DISTRICT  
RICHARD M. MATSUURA

THIRD DISTRICT  
MALAMA SOLOMON

FOURTH DISTRICT  
MAMORU YAMASAKI

FIFTH DISTRICT  
RICK REED

SIXTH DISTRICT  
RANDY IWASE

SEVENTH DISTRICT  
GERALD T. HAGINO

EIGHTH DISTRICT  
MIKE MCCARTNEY

NINTH DISTRICT  
STANLEY T. KOKI

TENTH DISTRICT  
MARY GEORGE

ELEVENTH DISTRICT  
DONNA R. IKEDA

TWELFTH DISTRICT  
STEVE COBB

THIRTEENTH DISTRICT  
BERTRAND KOBAYASHI

FOURTEENTH DISTRICT  
ANN KOBAYASHI

FIFTEENTH DISTRICT  
MARY-JANE MCMURDO

SIXTEENTH DISTRICT  
RUSSELL BLAIR

SEVENTEENTH DISTRICT  
ANTHONY K. U. CHANG

EIGHTEENTH DISTRICT  
MILTON HOLT

NINETEENTH DISTRICT  
DENNIS M. NAKASATO

TWENTIETH DISTRICT  
RICHARD S. H. WONG

TWENTY-FIRST DISTRICT  
NORMAN MIZUGUCHI

TWENTY-SECOND DISTRICT  
ELOISE YAMASHITA TUNGALAN

TWENTY-THIRD DISTRICT  
MIKE CROZIER

TWENTY-FOURTH DISTRICT  
JAMES AKI

TWENTY-FIFTH DISTRICT  
LEHUA FERNANDES SALLING

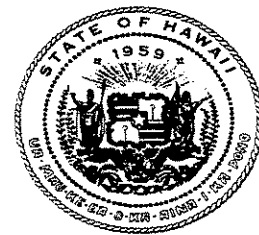
CHIEF CLERK  
T. DAVID WOO, JR.

The Senate  
The Sixteenth Legislature

of the  
State of Hawaii

STATE CAPITOL  
HONOLULU, HAWAII 96813

February 24, 1992



Ms. Jackie Mahi Erickson  
Vice President  
Corporate Counsel  
Hawaii Electric Company, Inc.  
P.O. Box 2750  
Honolulu, Hawaii 96840-0001

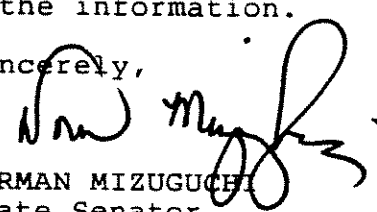
Dear Ms. Erickson:

I want to thank you for sending me HECO's booklets  
about electric and magnetic fields.

I am very pleased to know that HECO is  
conscientiously guarding the safety of its employees  
and customers by attempting to answer every question  
regarding this subject.

Again, thank you for the information.

Sincerely,

  
NORMAN MIZUGUCHI  
State Senator

NM/jt

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-00

COPY



Richard M. Sekiya  
Manager  
Distribution Engineering Department

February 21, 1992

Hawaii State Department of Health  
Environmental Health Division  
P. O. Box 3378  
Honolulu, Hawaii 96801

Attention: Mr. Leslie Au

Dear Mr. Au:

Subject: Kamehame Ridge 46kv Relocation  
Results of E.M.F. Calculations

In response to your request, attached for your records are:

1. The location map.
2. The sketch of the profiles showing the relative location of the poles to the property line.
3. The data from the calculations.
4. The graph of the data.
5. The summary of the results by location.

Please call Mr. Roy Hiyama at 543-7925 if you have any questions.

Very truly yours,

Sucuma Elliot  
Senior Distribution Engineer  
Distribution Engineering Department

RH/SE:11

Attachments

Speaker  
DANIEL J. KIHANO  
Vice Speaker  
PETER K. APO  
Majority Leader  
BRIAN T. TANIGUCHI  
Majority Floor Leader  
DENNIS A. ARAKAKI  
Majority Whip  
TOM OKAMURA

**HOUSE OF REPRESENTATIVES  
THE SIXTEENTH LEGISLATURE**

STATE OF HAWAII  
STATE CAPITOL  
HONOLULU, HAWAII 96813



**DISTRICT REPRESENTATIVES**

1st — JERRY CHANG  
2nd — HARVEY S. TAJIRI  
3rd — WAYNE METCALF  
4th — DWIGHT Y. TAKAMINE  
5th — VIRGINIA ISBELL  
6th — MIKE O'KIEFFE††  
7th — DAVID MORIHARA  
8th — HERBERT J. HONDA  
9th — JOSEPH M. SOUKI  
10th — ROSALYN BAKER  
11th — DANIEL J. KIHANO  
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16th — TERRANCE W. H. TOM  
17th — MARSHALL K. IGE  
18th — WHITNEY T. ANDERSON†  
19th — CYNTHIA THIELEN  
20th — JACKIE YOUNG  
21st — DAVID D. STEGMAIER  
22nd — GENE R. WARD  
23rd — BARBARA MARUMOTO  
24th — JANE B. TATIBOUET  
25th — CALVIN K.Y. SAY  
26th — LES IHARA, JR.  
27th — BRIAN T. TANIGUCHI  
28th — JAMES T. SHON  
29th — DAVID M. HAGINO  
30th — DUKE BAINUM  
31st — CAROL FUKUNAGA  
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33rd — ROD TAM  
34th — SUZANNE N.J. CHUN  
35th — KENNETH T. HIRAKI  
36th — DWIGHT L. YOSHIMURA  
37th — DENNIS A. ARAKAKI  
38th — EMILIO S. ALCON  
39th — ROMY M. CACHOLA  
40th — KAREN K. HORITA  
41st — TOM OKAMURA  
42nd — CLARICE Y. HASHIMOTO  
43rd — DAVID Y. IGE  
44th — NOBORU YONAMINE  
45th — JULIE R. DULDULAO  
46th — PAUL T. OSHIRO  
47th — ANNELLE C. AMARAL  
48th — HENRY HAALILIO PETERS  
49th — PETER K. APO  
50th — EZRA R. KANOHO  
51st — BERTHA C. KAWAKAMI

†Minority Leader

††Minority Floor Leader

February 20, 1992

Jackie M. Erickson  
Vice President  
Corporate Counsel  
Hawaiian Electric Company  
P.O. Box 2750  
Honolulu, Hawaii 96840-0001

Dear Jackie,

Thank you for sending me the pamphlets which discussed Electric and Magnetic Fields: The EMF Story which was prepared by Hawaiian Electric Company.

Because it has been a concern of mine for a long time, I would appreciate if you would continue to send me information as it becomes available.

Again, thanks.

Sincerely,

Mike O'Kieffe  
Representative, 6th District  
West Hawaii/East Maui

MOK:jpp

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-0001



Jackie Mahi Erickson  
Vice President  
Corporate Counsel

February 14, 1992

The Honorable Andrew Mirikitani  
Councilman  
Honolulu City Council  
Honolulu Hale  
Honolulu, Hawaii 96813

Dear Councilman Mirikitani,

Electric and magnetic fields, or EMF, is something you have been hearing about and will probably continue to hear about as research continues to determine if such fields do indeed represent a potential hazard to the public.

Enclosed are pamphlets which discuss this controversial subject. *Electric and Magnetic Fields: The EMF Story* was prepared by Hawaiian Electric to address frequently asked questions about EMF in Hawaii. *Your Guide to Understanding EMF* is an industry-wide brochure we have found helpful in discussing the EMF issue. I trust you will find both of them helpful in understanding the EMF issue.

We would be happy to discuss this issue or provide additional information on request. Please call Kevin Doyle at 532-5860 to arrange a briefing or request additional information.

Sincerely,

Enclosures

cc: K. Doyle  
✓ W. Bonnet (w/o enc.)

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-0000



November 21, 1991

The Honorable Chairman and Members of  
the Hawaii Public Utilities Commission  
Kekuanaoa Building  
465 South King Street, 1st Floor  
Honolulu, Hawaii 96813

Dear Commissioners:

Subject: Electric and Magnetic Field Informational Booklets

Attached are two booklets regarding electric and magnetic fields ("EMF"); "Your Guide to Understanding EMF", published by the Culver Company, and "Electric and Magnetic Fields: The EMF Story", published by HECO. We are providing these two informational booklets to customers concerned with the subject of EMF and its possible health effects.

Sincerely,

Barry M. Utsumi, Manager  
Rate and Regulatory  
Affairs Department

Attachments

cc: C. W. Totto

chi:EMFP1

Hawaiian Electric Company, Inc. P.O. Box 2700 Honolulu, HI 96802-0007 (808) 543-5020



Richard L. O'Connell  
Vice President  
Customer Relations

October 10, 1991

Dr. Bruce Anderson, Deputy Director  
Hawaii State Department of Health  
Environmental Health Division  
P. O. Box 3378  
Honolulu, Hawaii 96801

Dear Bruce:

As we discussed yesterday, I am forwarding six copies each of two EMIF brochures which we are distributing to our customers who ask for them. I have enclosed a copy of our letter of transmittal that refers them to you for more information on health risks. We have only sent out about 40 copies of these to date.

If you have any questions about these materials or our procedures, please let me know.

Sincerely,

Enclosures

/ Copy: W. A. Bonnet

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-000



October 1, 1991

Dear Customer:

Enclosed are materials on electric and magnetic fields (EMF) which you requested.

Should you wish to have more information, please let us know. You may also obtain further information on the health risks of EMF from:

Dr. Bruce Anderson  
Deputy Director  
Hawaii Department of Health  
P. O. Box 3378  
Honolulu, HI 96801

Telephone: 548-4139

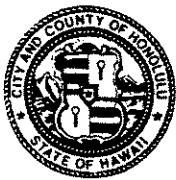
I hope this information meets your needs.

Sincerely,

Charlotte T. Kawazoe  
Director, Education &  
Consumer Affairs

CTK:rh

Enclosures



EWA NEIGHBORHOOD BOARD NO. 23

92-783 Laaloa Pl. • EWA BEACH, HAWAII 96707

August 12, 1991

TO: Bill Bonnett  
Hawaiian Electric Company

FROM: Jane A. Ross, Chair Ewa Neighborhood Board No. 23 *JK*.

SUBJECT: Ewa Development Plan Public Facilities Map Amendment  
for Ewa - Ewa Nui 138 KV Substation, DGP 91/E - 104 (IC)  
TMK: 9-1-18: POR. 01

On August 2, 1991, our Health/Safety/Human Services Committee met with Leslie Au of the Hazardous Evaluation Section of the State Health Department, a representative of the Department of General Planning, and three HECO representatives: Francis Hiramami, Senior Electrical Engineer; Bill Bonnett, Manager of the Environmental Department; and Eugene Yoshimi, the sub-station manager, and the full Board considered this matter at its regular monthly meeting on August 8, 1991.

We were informed that HECO needs to get the power from its providers located in Campbell Industrial Park to its Waiau power plant. To do this it is necessary to place a sub-station along the route. The new sub-station would be located in a presently unpopulated area near Farrington Highway with its transmission lines following the old OR&L right of way and Kaloi Gulch to Farrington Highway, and from there to the Waiau plant.

As a result of questions raised about the danger of electric and magnetic radiation to the users of Farrington Highway and the inhabitants of future developments on the Ewa Plain, we learned that:

1. The Department of Engineering and Public Policy of the Carnegie Mellon University in Pittsburgh, Pa. has stated that although there is evidence that such fields can produce various hormonal and other changes in living things, it is not yet clear if these changes can result in risks to public health such as the promotion of cancer, birth defects, and various neurological effects.
2. Studies done to date have produced mixed and inconclusive results and scientists as yet do not agree on whether there is a risk to public health or how serious the risk might be.





Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-0001 • (808) 543-562

FUEL 1-4  
MK/R



Richard L. O'Connell, P.E.  
Vice President  
Facilities

December 12, 1990

Dr. Bruce Anderson, Deputy Director  
Hawaii State Department of Health  
Environmental Health Division  
P. O. Box 3378  
Honolulu, HI 96801

Dear Bruce,

Enclosed are statements by four noted scientists on the potential of health effects of electric and magnetic fields (EMF). They were submitted to the EPA Science Advisory Board for their consideration in reviewing a forthcoming EPA report on this subject.

I thought you would find these reports of interest.

Sincerely,

Enclosures



STATE OF HAWAII  
DEPARTMENT OF HEALTH

P. O. BOX 3376  
HONOLULU, HAWAII 96801

March 16, 1990

JOHN C. LEWIS, M.D.  
DIRECTOR OF HEALTH

IN REPLY, PLEASE REFER TO:  
EPHSC

MEMORANDUM

To: Edward Y. Hirata, Director  
Department of Transportation

From: Director of Health

Subject: Draft Environmental Assessment and Health Implications of the Waiau-Makalapa No. 2 138-Kilovolt Hawaiian Electric Transmission Line

A review of the health effects information contained in the Draft Environmental Assessment and routing Report for the Waiau-Makalapa No. 2 138-Kilovolt Transmission Line Project has been completed. The information is essentially correct.

The nonthermal effects caused by electric or magnetic fields are not well understood. Some studies have suggested that low-power fields around the home may be more risky, if at all, than high-power 138-kilovolt transmission lines. Despite the distorted statements in a recent three-part article in The New Yorker, only three of five epidemiologic, human-population studies have associated cancer, birth defects, or neuropsychological problems with exposure to low-level electromagnetic fields. The findings are open to challenge because the studies were full of confounding factors, which are other environmental agents which could have contributed to the same adverse health effects.

Controlled laboratory experiments are then necessary, where the confounding factors and outside influences are eliminated. Regarding laboratory animal research, different electromagnetic fields and electric frequencies may be thought of as if they were different chemicals, some of which may be beneficial and some harmful. Almost none have been studied to find their good and bad effects at different doses (i.e., signal strengths) or lengths of exposure. Certain exposures may need to be limited because their effects include childhood leukemia, brain cancer, or retarded development. Other frequencies are used to cure cancer or promote bone and skin healing.

At this time, therefore, the Department of Health has no scientific, public-health objection to the construction of the line. HECO's Environmental Assessment document proposes the use of "low-reactance phasing," which is an arrangement of conductors which can reduce the electromagnetic field strengths at ground level under the transmission line. HECO proposes to use this arrangement

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-000



William A. Bonnet  
Manager  
Environmental Department

September 18, 1989

The Honorable James Shon  
State Representative  
State Capitol, Room 439  
Honolulu, Hawaii 96813

Dear Representative Shon:

As you had requested at the meeting in your office on July 19, HECO's Engineering Department has calculated the electric and magnetic field strengths in your fourth floor apartment from the 12 kV circuit immediately fronting the 1521 Alexander Street address.

	<u>E-Field</u> <u>(Volts Per Meter)</u>	<u>M-Field</u> <u>(Milligauss)</u>
Actual Normal Line Load	127	0.28
Maximum Rated Transformer Load	127	1.12

These fields are specifically related to the 12 kV source; they do not include fields which would be produced from secondary circuits, internal building wiring, or any electrical devices and appliances within the building. To provide some frame of reference for these numbers, I have attached tables from the Technical Information Paper prepared for the Waiiau-Campbell Industrial Park Transmission Line Project, showing fields produced by household appliances.

In a subsequent telephone conversation, you had also inquired about the concept of wire pairing to reduce magnetic field strengths through cancellation. Enclosed for your information are

The Honorable James Shon  
September 18, 1989  
Page 2

pages from the Congressional Office of Technology Assessment Report discussing the cancellation of magnetic fields in home wiring wherever the hot wire and ground wire are parallel and close together in the same conduit. This is a safe, economical, and acceptable practice due to the low voltage and therefore minimum wire insulation requirements. For the higher voltages associated with primary distribution and transmission systems, the use of uninsulated wires require a greater separation between wires which results in a lesser degree of magnetic field cancellation.

Sincerely,



Enclosure



TABLE 3

Typical Electric Field Values for Appliances (at 12 inches)

<u>Appliance</u>	<u>Electric Field, Volts/meter</u>
Electric Blanket	250*
Broiler	130
Stereo	90
Refrigerator	60
Iron	60
Hand Mixer	50
Phonograph	40
Coffee Pot	30

\* 1-10 kV/m next to blanket wires (13)

The electric field values were calculated for the proposed Waiau-CIP 138 kV transmission for a variety of configurations. The results are presented in Figures 1-6 as electric field lateral profiles for different locations along the line route. A lateral profile is a plot of the calculated maximum field as a function of distance away from the ROW center. The following table summarizes the electric field lateral profile plots:

TABLE 4

Calculated Electric Field Lateral Profiles

<u>Figure No.</u>	<u>Location</u>	<u>Configuration</u>
1	CIP Substation to Mango Tree Rd.	Appendix Fig. A-1
2	Mango Tree Rd/Old Fort Weaver Rd	Appendix Fig. A-1
3	Farrington Highway	Appendix Fig. A-2
4	H-1 Freeway	Appendix Fig. A-3
5	Kamehameha Highway	Appendix Fig. A-4
6	Lehua Elementary School	Appendix Fig. A-5

The electric field for the proposed Waiau-CIP 138 kV line will vary from about 0.1-0.2 kV/m at the ROW edge to about 0.5-0.8 directly under the conductors near midspan. The maximum electric field reported in the lateral profiles occurs in a relatively small area of the ROW (about 5% of total area) near midspan, and near the location where the conductors sag closest to the ground.

The magnetic field under transmission lines is relatively low - at least in comparison with measurements near many household appliances and other equipment. The magnetic field near a point appliance decreases rapidly with distance away from the device. The magnetic field also decreases with distance away from line sources, such as powerlines, but not as rapidly as appliances. Since the magnetic field is caused by the flow of an electric current, a device must be operated to create a magnetic field. The magnetic field of a large number of typical household appliances was recently measured by IITRI for the U.S. Navy (17) and by Enertech Consultants (18) for EPRI. Typical values of Table 5 are given as numerical examples to understand magnetic field values in units of milliGauss (thousandths of a Gauss):

TABLE 5

Magnetic Field Due to Household Appliances

<u>Appliance</u>	Magnetic Field - milliGauss (1 mG = 0.001 G)	
	<u>12" Away</u>	<u>Maximum</u>
Electric Range	3-30	100-1,200
Electric Oven	2-5	10-50
Garbage Disposal	10-20	850-1,250
Refrigerator	0.3-3	4-15
Clothes Washer	2-30	10-400
Clothes Dryer	1-3	3-80
Coffee Maker	0.8-1	15-250
Toaster	0.6-8	70-150
Crock Pot	0.8-1	15-80
Iron	1-3	90-300
Can Opener	35-250	10,000-20,000
Mixer	6-100	500-7,000
Blender, Popper, Processor	6-20	250-1,050
Vacuum Cleaner	20-200	2,000-8,000
Portable Heater	1-40	100-1,100
Fans/Blowers	0.4-40	20-300
Hair Dryer	1-70	60-20,000
Electric Shaver	1-100	150-15,000
Color TV	9-20	150-500
Fluorescent Fixture	2-40	140-2,000
Fluorescent Desk Lamp	6-20	400-3,500
Circular Saws	10-250	2,000-10,000
Electric Drill	25-35	4,000-8,000

are "pumped" onto the wires by electric generators. Because the charge in the wire changes from positive to negative at power-frequency, the associated electric fields are dynamic. Dynamic fields can be depicted by taking some time-average measure of their intensity and direction. The most common convention is to use the "root-mean-square" field. Figure 2-4 is a representation of the power-frequency electric field of a household coffee maker obtained using the root-mean-square.

As with fields from other power-frequency sources, the electric field from a coffee maker loses intensity rapidly with distance. Figure 2-5 shows how electric field strength changes with distance for electric fields from EHV transmission lines, distribution lines, and typical appliances.

### 2.2.2. Magnetic Fields

In the nineteenth century, scientists discovered that a current-carrying wire exerts a force on any charged particle moving nearby. This force was called the magnetic force. Its magnitude is proportional to the current in the wire and the velocity and charge of the moving particle. The magnetic field is a mathematical means of representing the magnetic force. Like electric fields, magnetic fields are represented graphically by sets of lines as shown in Figure 2-6.

There are several different units used to describe magnetic fields. The proper unit of magnetic field intensity is the Ampere per meter (analogous to the V/m for electric fields). Often, magnetic field strength is indicated by a related quantity called the magnetic flux density which is the number of field lines that cross a unit of surface area. The unit of magnetic flux density that is encountered most often in the power-frequency literature is the gauss (G). Sometimes, the magnetic flux density is given in tesla (T). There are 10,000 gauss in each tesla. For fields in air or in biological tissues, the magnetic flux density in gauss is 1/80th of the magnetic field intensity in A/m. The gauss and tesla are large units. Sixty hertz magnetic fields are commonly reported in thousandths of a gauss or milligauss (mG).

Like power-frequency electric fields, magnetic fields from power systems are dynamic and are generally described by some time-averaged quantity such as the root mean square. Figure 2-7 shows the root mean square field of a household coffee maker.

Magnetic field intensity drops off rapidly with distance. Figure 2-8 shows this relationship for magnetic fields from EHV transmission lines, distribution lines, and typical appliances. The magnetic fields around many appliances are stronger than the magnetic fields under either transmission or distribution lines. Appliance fields typically fall off faster with distance, however, than do fields from overhead powerlines. This results from the fact that appliances are less extended in space than are long power lines.

Electric and magnetic fields produced by power lines and other sources can be either measured using a "field meter" or calculated given information on voltage and current. For transmission lines, such calculations can be quite accurate. Published reports describing fields from various sources are listed in Table 2-1.

Recent epidemiological studies relating the incidence of certain cancers to magnetic fields in the household environment [Wertheimer 79, Wertheimer 82, Savitz 87a, Stevens 87] have created a growing need to understand the various sources of magnetic fields in the home. These sources include 1) appliances, 2) wall wiring, 3) ground currents in plumbing, gas lines, and steel girders, and 4) overhead and underground distribution wires [Barnes 87]. The most intense magnetic fields in the home are found

near appliances (particularly those with small motors or transformers such as hairdryers and fluorescent light fixtures). Because appliance fields fall off rapidly with distance and since people generally spend only brief amounts of time very close to appliances (with the exception of electric blankets and a few other appliances), appliances are usually not dominant contributors to time-averaged magnetic field exposure. However, since it is not known what aspect of the field, if any, is biologically important, care must be taken in making inferences about "exposure" from this fact.

Magnetic fields from wall wiring can be quite small because the field created by the current in the "hot" side of the line is canceled by the field created by the equal and opposite current in the parallel "neutral" (or ground) wire. This cancellation is greatest when the hot and neutral conductors are close together as they are in ROMEX cable or when both conductors are run through the same conduit. Many older homes have "knob and tube" wiring in which the hot and neutral conductors are separated by many inches. Wall wiring of this type can make significant contributions to the average magnetic field in homes.

Ground currents arise because the neutral (or grounded) wires of distribution lines are usually physically connected to the earth at many points along the line. These connections are made either through metal rods driven into the ground or by direct connection to water lines. Connections to earth are generally made at every distribution transformer and at every service drop (the point where electric lines enter the home). These ground connections provide alternate paths for distribution currents to return to local transformers or substations. This leads to power-frequency currents in water and gas plumbing. Because ground currents are not balanced by equal and opposite currents in parallel conductors, the magnetic fields that they produce can contribute substantially to the overall magnetic field in homes.

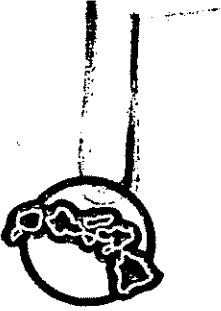
Barnes and colleagues found that houses in the Denver area were often close enough to overhead or underground distribution lines that the magnetic fields produced by the lines could account for a large fraction of the fields measured in the homes [Barnes 87]. Their estimates of the contributions of appliances, house wiring, ground currents, and distribution lines to magnetic fields in houses is shown in Table 2-2. Again, because it is not clear what, if any, aspect of the field is biologically important, care should be taken in making inferences about "exposure" from these numbers.

Table 2-2: Sources of 60 Hz magnetic fields in residences. Adapted from [Barnes 87].

Source	Magnetic Flux Density
Appliances	6 mG to 25 G
House wiring	.01 mG to 10 mG
Ground currents	up to 5 mG
Distribution lines	.01 mG to 10 mG



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William A. Bonnet  
Manager  
Environmental Department

August 30, 1989

The Honorable James Shon  
State Representative  
State Capitol, Room 439  
Honolulu, Hawaii 96813

Dear Representative Shon:

I appreciate your letter of August 22 requesting information on the subject of, EMF and sharing your report on Electromagnetic Radiation, dated August 17. At your earlier request, I shared with you on July 27 extensive information on the subject, including the Office of Technology Assessment (OTA) report. This Congressional report provides a broad perspective on the issue, which your audience may find informative and helpful. I hope there is recognition in the community that the New Yorker articles do not constitute a definitive assessment of EMF.

I have included some additional information for your reference and use. The first is a program by EPRI for epidemiological studies of utility workers. Note that the research is to be conducted by David Savitz; it was his research proposal (copy enclosed) that was selected from among the candidates submitted. The study has been developed by Savitz, not EPRI, and excludes smaller utilities (such as HECO) for cost-effectiveness reasons. Savitz anticipates the study population of 1.6 - 1.8 million person years will yield "statistically powerful, and therefore persuasive" results by the end of 1991. Also enclosed is a recent Forbes articles on EMF, commenting on the New Yorker series.

Sincerely,

RP 2964-5: EPIDEMIOLOGIC STUDY OF UTILITY WORKERS EXPOSED TO  
ELECTRIC AND MAGNETIC FIELDS

Phase I: Summary of Activities and Major Conclusions

Principal objectives of the first phase of the project were to identify companies willing to participate in the study, determine whether the proposed large scale study was feasible, and develop a proposal for the main study. All three major objectives were accomplished.

Ten electric utilities indicated interest in participating in Phase I. Two of these companies were judged to be too small to justify the cost of including them in the study. Five utilities were invited to participate. Two of these companies are very large (> 20,000 current employees), two are large (10,000-20,000) and one medium sized (5,000-10,000 current employees). Two other medium sized companies indicated interest at a relatively late date, and were invited to participate as "alternates" in the event that one of the primary candidates decided not to continue with Phase 2.

Dr. Savitz has concluded that a large-scale epidemiologic study of leukemia and brain cancer among employees of the five participating utilities is feasible. His conclusion is based on the following key points:

- Record retention policies at the five companies make it possible to identify persons employed over a relatively long period (e.g. 1950 or 1955 through 1985). Identification and demographic information on the records is adequate to allow follow-up of these workers after they leave the company.
- Study population is large enough to yield a statistically powerful, and therefore persuasive, study. Estimated size of the study population is 1.6 - 1.8 million person-years of observation (1 person-year = 1 person x 1 year). Expected numbers of cancers of interest in the study population are as follows: Total leukemias - 215; acute non-lymphocytic leukemias - 120; and brain cancers - 185.
- Exposure to magnetic fields of present employees of participating utilities varies substantially among jobs and by activity within jobs. Thus, the investigators

conclude that it is feasible to combine job history with measurements of E/M fields appears to estimate past exposures. If an excess risk of cancer exists among more highly exposed employees, the nature of that relationship can be examined in analysis of the study.

## Phase 2. Proposed Study Design and Schedule

Classically, disease patterns in large employed populations are analyzed using the design proposed for this study, the historical cohort mortality study. A cohort is simply a group of people who are followed over time to determine what happens to their health. It is common practice to identify such a group through records and to trace its members from some time in the past up to the present. In this case, the cause of death is the outcome of interest.

Cohort studies require the following steps:

1. Cohort definition and identification. The cohort to be followed in this study comprises white males who were employed continuously for at least six months at one of the five participating companies between January 1, 1950 (1955 in one company) and December 31, 1986. These people will be identified (name, social security number, date of birth) by review and abstraction of employment and payroll records at the participating companies. Employment history (job title and duration of employment in each job) will be abstracted at the same time.
2. Cohort follow-up. Persons identified in the first step are followed up, using company and other records, to determine their fate: Are they alive or dead? If dead, what was the cause of death?
3. Exposure assessment. Measurement of exposure is not, strictly speaking, part of the cohort design. However, the single largest source of uncertainty in previous epidemiologic studies of occupational exposure to EMF is exposure assessment. The proposed approach to measuring exposure is a major advance in studying the supposed association of magnetic field exposure and cancer risk. Extensive efforts are also being made to identify other occupational exposures, e.g. to chemicals, that might influence leukemia or brain cancer risk.

4. Analysis. The primary purpose of this study is to test the hypothesis that occupational exposure to power frequency magnetic or electric fields is associated with increased risk of acute non-lymphocytic leukemia or brain cancer. The hypothesis is tested by comparing mortality rates for all causes of death and for the specific causes of interest (all leukemia, acute non-lymphocytic leukemia, and brain cancer) among more-exposed versus less-exposed subgroups of the study population. If the hypothesis is true, more-exposed workers will have higher age-specific mortality rates than less exposed workers.

Project Schedule Work on Phase 2 of the project should be complete by the end of 1991. Record review and abstraction, mortality follow-up, and preliminary analysis would proceed simultaneously at all five companies. See detailed timeline (overleaf).

RSB:phs2sum:cj

## Insights

### MONEY & INVESTMENTS

*To those who worry about the health hazards of electricity: Meet the late James Thurber's grandma; she was convinced that wall sockets leaked dangerous stuff.*

# ELECTROPHOBIA

By Peter Huber



McCaw Cellular can't put an antenna on a building in Seattle because workers on the top floors are worried about radiation. A nation of hypochondriacs, we are developing a phobia toward technology worthy of a primitive tribe. I am reminded of an earlier time:

"This room is equipped with Edison Electric Light. Do not attempt to light with match. The use of electricity for lighting is in no way harmful to health, nor does it affect the soundness of sleep." In 1892 these signs started appearing in hotels and public buildings newly equipped with electricity. It took a few decades to overcome the public's fears.

Now comes a *New Yorker* journalist, Paul Brodeur, to declare that the early phobias were right. His pen is itself a remarkable generator, of publicity at least. Extra-low-frequency (ELF) electromagnetic fields from transmission lines, video display terminals, and yes, electric lights have all become today's fashionable environmental terrors.

One strand of research suggests that low-level fields can affect cells in carefully contrived laboratory

conditions. But the effects come and go, apparent at one frequency, disappearing at the next, pointing in different directions in different laboratories, altered by (among other things) the local orientation of the earth's magnetic field. Effects don't rise with field intensity.

Then there's the epidemiological work. It all started when an extremely green researcher drove around Denver hunting for an environmental factor to explain childhood leukemia. Many of the victims seemed to live near power line transformers, she decided. She published a paper on the correlation. But she didn't systematically measure the fields themselves. Others did and found little relationship between her wiring observations and actual field intensities.

More recently, epidemiologist David Savitz explored 52 correlations between childhood cancer, measured electric and magnetic fields, and wiring codes. He found no association with electric field levels, and none that were statistically significant with magnetic fields, though here he did claim to see some suggestive trends. There was a slightly stronger correlation with wiring codes. Only one data group (consisting of eight cancer cases and two controls) stood out as distinctly unusual. Savitz, as translated by Brodeur, sounds almost apocalyptic. But "it would be erroneous to interpret the literature as a series of replicated positive results," says Savitz himself. Epidemiological studies, he might have added, uncover weak correlations of this kind all the time. Almost all are eventually discarded as spurious.

This we know. ELF fields of ordi-

nary intensity don't disrupt chemical bonds, as ionizing radiation does, nor do they heat tissues. Living cells naturally maintain electric fields thousands of times stronger than man-made fields in the everyday environment. The strength of a typical man-made magnetic field in the home is vastly lower than the earth's, by factors of 100 or more.

Basic physics and common sense notwithstanding, claims of magical healing powers from ELF fields have been floated over the years about as often as claims of pernicious hazard. Over 200 effects have been reported. Most have been at the borderline of experimental detectability. The claims shift quickly, always one step ahead of the good science. It's what Nobel physicist Richard Feynman called cargo-cult science. After World War II, South Sea islanders set up dummy airbases, complete with hangars and flares, to attract back the military planes that had once brought comfort and plenty. Bad scientists go through similar rituals and motions of the scientific inquiry. But the planes never land.

In recent years, the health effects of ELF fields have been reviewed by the National Academy of Sciences, the World Health Organization and commissions in Florida, New York, Australia and England. None concludes that any human health hazard has been proved. The evidence of hazard is "not close to meeting established standards of scientific acceptance," says Robert K. Adair, Sterling Professor of Physics at Yale. "The results are about as believable as claims of perpetual motion." Or cold fusion.

The electrophobiacs will nonetheless be fortified in their fears by a report recently published by Congress' Office of Technology Assessment, which somberly concludes that "there are legitimate reasons for concern," and counsels "prudent avoidance" of ELF fields. James Thurber's grandmother must be smiling in her grave. She "lived the latter years of her life in the horrible suspicion that electricity was dripping invisibly all over the house," her grandson wrote in a 1933 essay. She spent her days turning off the wall switches that led to empty sockets, "happy in the satisfaction that she had stopped not only a costly but a dangerous leakage." Paul Brodeur: Meet Thurber's grandma. ■

*Peter Huber, a senior fellow of the Manhattan Institute, is the author of Liability: The Legal Revolution and its Consequences.*

EPRI RESEARCH PROJECT RP2964-5  
Evaluation of Proposal:

"EPIDEMIOLOGIC STUDY OF ELECTRIC UTILITY EMPLOYEES EXPOSED TO  
ELECTRIC AND MAGNETIC FIELDS: PHASE II"

University of North Carolina, Contractor  
David A. Savitz, Principal Investigator

Prepared by  
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Project Manager, Radiation Studies Program  
Environment Division, EPRI

EPRI RESEARCH PROJECT RP2964-5  
Evaluation of Proposal:

"EPIDEMIOLOGIC STUDY OF ELECTRIC-UTILITY EMPLOYEES EXPOSED TO  
ELECTRELECTRIC AND MAGNETIC FIELDS"

University of North Carolina, Contractor  
David A. Savitz, Principal Investigator

## Introduction

Dr. Savitz and his collaborators were awarded a contract for Phase I of this study on the basis of their response to a 1987 EPRI Request for Proposals (RFP). Six responses to the RFP were evaluated by reviewers within EPRI, by representatives of electric utilities, and most importantly, by peer reviewers. Reviewers in all three categories judged the proposal by Dr. Savitz and his colleagues to be the best of six responses received. Phase I of the project resulted in a feasibility assessment and revised study design, which make up the proposal considered in this evaluation.

The eight criteria used in this evaluation were developed by a Working Group of the International Electricity Research Exchange expressly for evaluation of epidemiologic studies of the effects of electric and magnetic fields (EMF) on human populations (1). These criteria, in turn, rely substantially upon "guidelines" proposed by Hill (2).

### Criterion 1. Study Design

A historical cohort mortality study is proposed. In a study of this type, subjects are identified through various types of administrative records made at some time in the past. Persons eligible for inclusion in this study are white males employed full time for at least six months during the study period in non-nuclear operations of one of five participating utilities. In all instances, the study period ends December 31, 1986. Beginning dates of the study period range from 1950 - 1955, and differ among the five participating companies, depending on the availability of suitable records.

Using various publicly available records, each member of the cohort will be traced ("followed up") to determine whether he is alive or dead. If he is dead, the cause of death will be determined. Mortality rates will then be calculated on the basis of person-years of observation (1 person-year = 1 person observed for 1 year). These "crude" rates will be statistically adjusted to account for the age of the population, producing standardized mortality ratios ("SMRs") for all causes of death and for specific causes (e.g., accidents, cardiovascular disease, all cancers, brain cancers, all leukemias, acute non-lymphocytic leukemia).

SMRs for the study population can then be compared to a standard population (all US white males). As noted in the IERE report, however, comparisons among sub-groups within the study population (for example, exposed versus unexposed workers) are of greater interest and relevance. This study is that is large enough to allow informative and precise comparisons among subgroups of the cohort, a very important improvement over previous occupational studies of EMF and cancer.

### Criterion 2. Exposure Assessment

In the ideal epidemiologic study exposure is measured prospectively,

as it occurs. The researcher, in such a case, controls the quality and relevance of the data. However, when the disease outcome of interest is relatively uncommon and has a long induction period, as is the case with cancer, prospective studies are often impractical. The alternative approach is to use routinely collected records to identify cases of disease that have occurred over a relatively long period. An unavoidable limitation of this historical approach is that the truly relevant EMF exposures cannot be measured -- they must be estimated.

As highlighted by Section VII of the IERE Final Report, exposure assessment is a major shortcoming of all existing occupational studies of EMF and cancer, which have relied almost exclusively on job title (as indicated on a death certificate or other secondary source) as an indicator of presumed exposure. One major contribution of this study is its more sophisticated approach to exposure characterization.

Past exposure will be estimated on the basis of a "job-exposure matrix" which incorporates information on job history, estimates of exposure associated with each job held, and information on other possibly related exposures (confounders -- see Criterion 8). The basis for estimating exposures to EMF will be an extensive program of measurements among current employees, which will focus on job tasks defined in relation to exposure.

Job-related exposure can be defined as the sum of exposures in each task comprising the job. Exposure associated with each task then can be weighted by the time spent performing the task. This approach allows exposure estimates to take account of changes in time spent on each task as work practices over time. For example, the introduction of "bucket trucks" in US utilities, beginning in 1965, allowed many operations on energized lines to be completed more quickly.

In studies of EMF exposure and cancer, no generally accepted measure of "dose" exists; a bio-physical model describing the mechanism by which externally applied EMF could initiate or promote cancer has yet to be developed. Several mechanisms have been proposed, with varying degrees of supporting theoretical and observational support, but these proposed mechanisms are best described as hypotheses. Defining relevant exposure parameters therefore presents a problem. The scientific reviewers of the proposal strongly recommended that the researchers attempt to develop one or more appropriate exposure indices for magnetic and electric fields, a recommendation that EPRI plans to emphasize strongly.

Exposure assessment work in Phase I of this project and related work in the EMDEX project have shown that different work environments and jobs are characterized distinctive exposure patterns. The statistical distribution of these exposures are generally not Gaussian and are not easily summarized by a single parameter such as the mean or variance. Both the researchers at North Carolina and the scientific reviewers of the study have concluded that it would be a mistake to fix upon a single field parameter or a single summary statistic characterize the "typical" EMF exposures associated with different jobs and tasks. Among the parameters that will be examined are the mean, geometric mean, and ninetieth percentile of the flux density, and an index of periodicity of exposure.

### Criterion 3. Specificity

This study has the advantage of being able to examine a broad range of disease end points in relation to EMF exposure. The study population will be large enough to allow fairly precise measures of risk of specific diseases in relation to exposure (See Criterion 4). Previous studies



suggest that acute non-lymphocytic leukemia (ANLL) and brain cancer are positively correlated with EMF exposure. For both of these cancers of primary interest, unfortunately, the diagnoses on death certificates are often not as high as might be hoped. Therefore, for all death certificates that mention leukemia or brain cancer, confirmation of diagnoses (including pathology reports) will be sought from hospital records.

The specificity of the apparent association between ANLL and EMF seen in previous studies can be thoroughly examined by this study, because all causes of death will be ascertained. If rate ratios (RR) for exposed vs. non-exposed members of the cohort increase with increasing specificity of diagnosis (i.e., all cancers < all leukemia < ANLL), this can be taken as support for the idea that the association between EMF and risk of ANLL is causal.

It is important to emphasize, as the IERE report does, that lack of specificity does not necessarily mean that an observed association between EMF exposure and cancer mortality is non-causal. Indeed, one hypothesis that has been put forward (Wertheimer and Leeper, 1982) is that long term exposure to higher than average magnetic fields promotes progression or enhances growth of tumors arising from cells transformed by other agents.

The other aspect of "specificity" addressed by the IERE report is specificity of exposure information. The historical nature of the study introduces a certain minimum irreducible uncertainty about exposure (see Criterion 2., above). By definition, the exposures of greatest interest cannot be measured, because they occurred in the past. The exposures--both to EMF and to other agents of possible interest (see Criterion 8)--that typify these jobs today, however, can be well characterized. These present day measurements are the foundation for estimating past occupational exposures. This study and the Ontario Hydro - Hydro Quebec - Electricite de France collaborative study under the direction of Dr. Gilles Theriault of McGill University, Montreal, represent the most thorough characterization of EMF exposure yet undertaken in occupational epidemiologic studies.

#### Criterion 4. Strength of Association

Whether this study will find a positive association between exposure and disease risk is of course still unknown. For purposes of this evaluation, the relevant issue is the ability of the study to detect a difference in mortality rates for ANLL and brain cancer between exposed and unexposed workers, if such a difference actually exists. A closely related issue is the precision with which this difference can be measured.

Acute non-lymphocytic leukemia is the least common of the diseases of primary interest in this study. Previous studies suggest that, if an excess risk exists, the age standardized mortality rate for ANLL among exposed employees would be at least 1.5 times the rate in unexposed workers. The study has been designed, therefore, to detect a relative risk of 1.5 among exposed workers. If a rate ratio (RR) of 1.5 were found to exist, the expected upper and lower bounds of the 95% confidence interval on the RR would be 1.2 and 1.9, respectively. The IERE report suggests applying a "precision index", the ratio of lower to upper confidence limits. Using the assumptions outlined in Appendix F of the proposal, the lower and upper confidence limits for the RR of ANLL are 1.2 and 1.9, giving a ratio of 0.63, a quite respectable degree of precision.

Further narrowing the expected width of the confidence interval does not appear practical. Note in Appendix F ("Calculation of Person Years and Expected Number of Cases") that increasing the person-years of observation from 1.6 million to 2.2 million yields a negligible increase in

precision, with lower and upper confidence limits of 1.2 and 1.8, respectively, on a RR of 1.5. The "precision index" is  $1.2/1.8 = 0.67$ . Adding the additional persons to the cohort would likely increase the cost of the study by 40 -60%.

#### Criterion 5. Dose Response Relationship

The term "dose response relationship" is customarily used somewhat loosely in epidemiology. Information on "dose" as the concept is understood in pharmacology or toxicology (as concentration or energy deposition in a target tissue or organ system) is very rarely available in epidemiologic studies of exposures to environmental agents. Epidemiologists seek to identify relationships between measured or estimated exposure and disease occurrence. Is disease risk higher among persons exposed to more intense fields? For a given exposure intensity, does disease risk increase with longer exposure? These relationships have not yet been investigated in an occupational study. Within the limitations discussed under Criterion 2. above, a detailed exploration will be undertaken.

Some researchers have questioned whether this "paradigm" that more exposure is worse is appropriate to study of the relationship between magnetic fields and cancer risk, citing evidence of "windows" of frequency, time, and intensity from experimental studies. These phenomena, to the extent they have been demonstrated, have to do with flux of ions across membranes in laboratory cell and tissue preparations. No animal study has yet examined whether EMF exposure causes cancer, much less attempted to characterize the relationship in a detailed fashion. Epidemiologic studies are not appropriate for identifying such relationships.

#### Criterion 6. Disease Ascertainment

Disease ascertainment methods for all study subjects will be the same. Exposure history will not influence the completeness of disease ascertainment or the source of information on disease status.

In a historical cohort study, which relies on historical records, active cooperation of subjects or next of kin is not required. The goal of the study is to determine the fate of all subjects who meet eligibility requirements for participation in the study. The first step is simply to determine whether the subjects were alive or dead at the end of the study period (December 31, 1986 in this case). For some subjects, the usual sources of such information (Social Security or other databases) will provide no information. These subjects are termed "lost to follow-up". The goal of follow-up and tracing activities of sub-contractor Westat is to make this fraction as small as possible. In this cohort, which is characterized by low turnover and long tenure, loss to follow-up is not expected to be a major problem.

#### Criterion 7. Temporal Relationship

The issue of temporal relationship of exposure to the onset of disease arises most often in connection with cross-sectional surveys, and occasionally in relation to case control studies. Since the basis for exposure attribution is employment history, there will be no doubt about the temporal relationship of job-related exposure to the date of death.

#### Criterion 8. Other Explanations (Confounders)

Confounding, i.e., a spurious association between EMF and cancer that is actually due to some other agent, can only present a problem if two circumstances are present:

- 1) The other agent or agents must truly cause the disease, and
- 2) Exposure to the other agent(s) must be strongly correlated with EMF exposure.

Only a few chemical and physical agents that cause leukemia and brain cancer in humans have been definitely identified; a few other suspect agents or classes of agents have been identified. Ionizing radiation clearly causes both leukemia and brain tumors. Benzene and benzidine are labeled leukemogens by the International Agency for Research on Cancer (IARC) (3,4). N-nitroso compounds cause brain tumors in animals and are suspected to cause brain tumors in man(5,6,7). "Organic solvents" generically have been implicated as causes of both leukemia and brain cancer, on the basis of epidemiologic studies of rubber and chemical workers (8). However, the evidence linking specific solvents (e.g., 1,1,1- and 1,1,2-trichloroethane, dichloroethylene, carbon tetrachloride) to leukemia or lymphoma in humans or animals is inconsistent and weak, although there is clear evidence that several of these solvents cause liver tumors in animals (9).

Ionizing radiation exposure occurs in nuclear power plants, but persons who worked exclusively in nuclear facilities will not be included in this study. Some persons who transferred to the non-nuclear portion of a utility from a nuclear generation unit may be included in the study, but are expected to constitute a very small proportion of the cohort – probably 1-2 % or less. In any event, there is no a priori reason to expect such persons would be more likely to work in jobs with high EMF exposure.

Benzene and various brand-name products were used in the utility industry in the past, but the quantities involved were not large. "Organic solvents" of various kinds were and are widely used. N-nitroso compounds are not widely used or present in utility work areas. The presence of these chemicals in the utility environment, both as generic chemicals and as constituents of various brand name products, will be documented.

In summary, concurrent exposures to certain chemicals and EMF could give rise to a spurious association between EMF and leukemia and/or brain cancer. In order to detect this "confounding effect", exposure to benzene, "organic solvents", and certain other chemicals during the study period will be carefully evaluated. Persons whose job histories include both a high likelihood of exposure to EMF and a high probability of having been exposed to benzene or other organic solvents are of particular concern. If a confounding effect exists, data quality should be adequate to detect it and adjust for it in the analysis.

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Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-00



August 10, 1989

Ms. Patsy Mink  
P.O. Box 479  
Honolulu, HI 96809

Dear Patsy:

Thank you for your letter of August 8 expressing an ongoing interest in the Waiiau-CIP transmission line project. As you indicate, there have been a number of articles on electromagnetic fields which we, like you, continue to follow very closely.

The New Yorker series, though well-intended, was a disservice to readers because it was highly selective in the information referenced, which necessarily influenced the conclusions reached. I have enclosed a copy of another perspective on some of the points raised in all three articles.

We believe the Office of Technology Assessment report, prepared by Carnegie Mellon, to be a balanced assessment of the EMF situation today and have enclosed a copy for your perusal. And though we don't have an inventory which allows us broad dissemination of this document, I trust you will share the information it contains with those people to whom you distributed copies of the New Yorker articles. You may also be interested in the enclosed Time article.

You are correct in that future community meetings about the project are planned, and you can be sure that we will keep you apprised of their dates, locations, and times. The environmental assessment, when completed, will be sent to you.

As you know, we retained the services of Dr. Michael Silva of Enertech, Inc. of Dr. Michael Silva of Enertech, Inc. at the inception of this project and did so because we anticipated that recent increases in news reports about EMF might cause some people to become concerned about the matter.

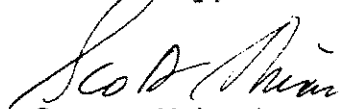
Ms. Patsy Mink  
August 10, 1989  
page 2

In response to concerns expressed at some community meetings on alternative alignments for the proposed transmission lines, we have asked Dr. Silva to expand the scope of the analysis which addresses potential EMF impacts of the transmission lines. The results of his analysis will include calculated electric and magnetic field strengths along the proposed route of the transmission line.

In light of the uncertainty on this issue, we will continue to gather as much information about it as possible. We would be pleased to share any such intelligence with you and trust that you will reciprocate and continue an avenue of dialogue with us about the EMF issue.

Thanks again for your letter.

Sincerely,



Scott Shirai  
Communications Supervisor

Enclosures



# PATSY T. MINK

P.O. BOX ~~96809~~  
HONOLULU, HAWAII ~~96809~~

Member, U.S. Congress  
1965-77

Member, City Council  
1963-67

Member, Hawaii Legislature  
1957-58, 1958-59, 1962-64

Assistant Secretary of State  
State Department 1977-78

P.O. Box 479  
Honolulu, Hawaii 96809  
August 8, 1989

Scott Shirai  
Hawaiian Electric Company  
P.O. Box 2750  
Honolulu, Hawaii 96840

Dear Scott:

I remain keenly interested in the Waiau-Campbell 138kv lines proposed to go through Waipahu town on Farrington Highway. There have been numerous articles on the potential health hazards from power frequency electromagnetic fields. In line with these concerns, I would like to again ask for a copy of the Environmental Assessments prepared on this project. I was told on my last phone call to you that the report was not yet ready for release. Please place my name on the list of persons who would like to have a copy and who would want to submit comments.

I just read a news article this week identifying Congressman Ted Weiss as supporting further research by the federal government into the potential health risks of power frequency electromagnetic fields. I have written to him for further information on his proposal.

Further the article stated that The Office of Technology Assessment has just issued a report on this matter. I have asked to receive a copy of this report also.

There was a very informative series in the June 12, 19, and 26 New Yorker magazine. I have made copies and sent them to various groups of people who have expressed an interest.

I am informed by Mary Ellen Nordyke-Grace that further community meetings are planned and asked to be kept informed on the dates of these meetings. Your update on the current status of the proposed lines through Waipahu town on Farrington Highway will be appreciated. In the meantime we are gathering information in response to the various questions raised about health hazards which concern us deeply.

Thank you very much.

Very truly yours,

  
PATSY T. MINK

Note my new mailing address:  
P.O. Box 479, Honolulu, Hawaii 96809

August 9, 1989

Ms. Patsy Mink  
P.O. Box 479  
Honolulu, HI 96809

Dear Patsy,

Thank you for your letter of August 8 expressing an ongoing interest in the Waiiau-CIP transmission line project. As you indicate, there have been a number of articles on electromagnetic fields which we, like you, continue to follow very closely.

The New Yorker series, though well-intended, was a disservice to readers because it contained many inaccuracies with an absence of clarification where needed. I have enclosed a copy of an assessment of some of the erroneous points raised in all three articles.

We believe the Office of Technology report performed by Carnegie Mellon to be a balanced assessment of the EMF situation today and have enclosed a copy for your perusal. And though we are unable to broadly disseminate copies of the same, I trust you will share the information it contains with those people to whom you distributed copies of the New Yorker articles. You may also be interested in the enclosed Time article.

You are correct in that future community meetings about the project are planned and you can be sure that we will keep you apprised of their dates, locations, and times. The environmental assessment, when completed, will be sent to you.

As you know, we retained the services of Dr. Michael Silva of Enertech, Inc. at the inception of this project and did so because we anticipated that the increase in news reports about EMF may cause some people to become concerned about the matter.

In response to concerns expressed at some of the community meetings on alternative alignments for the proposed transmission lines, we have asked Dr. Silva to expand the scope of the



analysis which addresses potential EMF impacts of the transmission lines. The results of his analysis will include calculated electric and magnetic field strengths along the proposed route of the transmission line. And these calculated field strengths are expected to be lower than the most stringent EMF standards anywhere in the country.

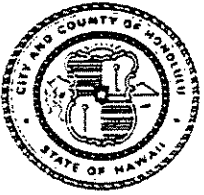
Nonetheless, we are concerned about this subject and will continue to gather as much information about it as possible. We would be pleased to share any such intelligence with you and trust that you would reciprocate and maintain an avenue of dialog with us about it.

Thanks again for your letter.

Sincerely,

Scott Shirai  
Communications Supervisor

Enclosures



**CITY COUNCIL**  
CITY AND COUNTY OF HONOLULU  
HONOLULU, HAWAII 96813 / TELEPHONE 523-4000

ARNOLD MORGADO, JR.  
COUNCIL

ENGINEERING DEPT.  
HAWAIIAN ELECTRIC CO., INC.  
**RECEIVED**  
JUL 26 1989  
JUL 21, 1989  
AM  
7:30 PM  
7/26/89 4:56

Dr. Brenner Munger, Manager  
Engineering Department  
Hawaiian Electric Company  
P.O. Box 2750  
Honolulu, Hawaii 96840-0001

Dear Dr. Munger:

Thank you for your July 19, 1989 response to the concerns raised about electric and magnetic fields.

I would appreciate receiving a copy of the new routing of the 138kV line project as soon as it is available.

Additionally, in a conversation with my staff, Mary Ellen Nordyke-Grace mentioned that HECO was conducting a local study on the EMF health effects. I would appreciate a copy when the study becomes available.

Thank you for your attention to this matter.

Sincerely,

A handwritten signature in dark ink, appearing to read "Arnold Morgado, Jr.", is written over a horizontal line.

ARNOLD MORGADO, JR.  
Councilmember  
District 8

AM:no

cc: R. K. McQuain  
A. Chang  
M. E. Nordyke-Grace  
N. Kashiwabara  
F. Karimoto

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-0000



July 19, 1989

Brenner Munger, Ph.D., P.E.  
Manager  
Engineering Department  
(808) 543-7110

The Honorable Arnold Morgado, Jr.  
Chairman, Honolulu City Council  
City & County of Honolulu  
Honolulu, Hawaii 96813

Dear Chairman Morgado:

Andy Chang has asked me to respond to your letter of June 28, 1989 forwarding the Wall Street Journal article on electric and magnetic fields (EMF). The subject of EMF health effects is a very complex and a very emotional issue and has been receiving considerable press coverage recently. I am sure you have read the article in the July 17, 1989 issue of Time (copy enclosed). Despite all the recent interest in EMF health effects, there is still no scientific consensus on this issue and no federal public health standards have ever been set. Only seven states, including Florida, have adopted standards to limit EMF from transmission lines.

We are very much aware of the EMF issue as it relates to the identification and evaluation of alternative alignments for transmission lines. A factor we would like to emphasize is that the voltage level of the 138,000 volt transmission lines on HECO's system is much lower than the voltage levels for the transmission lines currently causing concern on the mainland.

Early in the planning process for the Waiau-CIP and Waiau-Makalapa transmission line projects, we retained the services of Dr. Michael Silva of Enertech, Inc., who is a nationally-recognized expert in EMF.

In response to concerns about potential EMF effects expressed at HECO's public workshops on alternative alignments for the proposed transmission lines, we have directed Dr. Silva to expand the scope of the analysis which addresses potential EMF impacts of the transmission lines. The results of this analysis will include calculated electric and magnetic field strengths along the proposed route of the transmission lines. These calculated field strengths are expected to be lower than the most stringent EMF standards adopted to date. We will provide a copy of Dr. Silva's report when it is completed.

The Honorable Arnold Morgado, Jr.  
Chairman, Honolulu City Council  
July 19, 1989

Page 2

As further indication of our recognition of the EMF issue, we have relocated the alignment of the 138,000 volt transmission line proposed on Kamehameha Highway next to the Pearl City Elementary School to across the street from the school.

The issue presented in the Wall Street Journal article is a health effects issue. In fact, the issue is a societal, life style issue and has as much, if not more, to do with video display terminals, electric appliances and electric blankets as it does with transmission lines. This is illustrated by the attached graphic on various sources of magnetic fields.

While we certainly respect the concerns that are being expressed in this matter, some of the judicial actions being taken represent overly cautious reactions to problems which have not yet been well defined.

We would be glad to discuss this subject with you in more detail at any time.

Sincerely,

*Brenner Munger*

Enclosures

cc: A. Chang (w/encls)



## Health

## Panic over Power Lines

*Are the waves from electrical wires and appliances harmful?*

**L**ike the Land of Oz, technology has good and bad witches. The bomb is a bad witch, microsurgery a good one. Not so long ago, electricity was firmly in the benign category. After all, it delivers energy with great reliability and little expense. So essential has electricity become that more than 2 million miles of power lines, literally huge extension cords, crisscross the U.S. But nowadays many Americans are increasingly fearful that the electric and magnetic fields generated by such overhead cables pose a serious threat to human health, causing everything from learning disorders to cancer.

Alarm has been growing for more than a decade. Scores of lawsuits have been filed by residents of Texas, New York, California and Louisiana, forcing utilities to delay, reroute and sometimes abandon construction of power lines. Seven states have set limits for the strength of electric fields created along power-line paths; Florida has also adopted a standard for magnetic fields. Fremont, Calif., requires that potential buyers of new homes adjacent to overhead lines be warned of possible health risks. Last month in Florida a judge declared that pupils of Sandpiper Shores Elementary School near Boca Raton could not play in a major portion of the schoolyard because of nearby power cables.

Similar concerns have arisen in other nations as well. To calm public protest, a Canadian utility proposed buying all the homes along a 90-mile power line that is under construction. But residents became so upset that the government ordered a halt to work on a segment of the line. Fears were further heightened last month when *The New Yorker* magazine published a series on "The Hazards of Electromagnetic Fields." Author Paul Brodeur charged utility companies and public health officials with trying to gloss over the threat to health posed by power lines and computer terminals.

The concerns have some justification. Last month the U.S. Office of Technology Assessment issued a report concluding that power lines are a legitimate health issue. More troubling, it suggested that household wiring, appliances like toasters and electric blankets, and such items as TV sets and computer terminals, all of which create electromagnetic fields, might also have an impact on health.



A gym class at Sandpiper Shores Elementary School: a large part of the yard is off limits

*Though many studies are disturbing, there is still no clear-cut evidence of danger.*

Even so, the evidence that electric currents can be damaging is far from conclusive, scientists agree. Some epidemiological studies indicate a higher than normal incidence of cancer, including leukemia and brain tumors, among children and adults living or working close to power lines. A study in California found that pregnant women who worked on video-display terminals for 20 hours or more a week had twice the risk of miscarrying as other clerical workers. Such findings are suggestive, but the researchers admit that their work does not establish a direct cause-effect relationship.

**L**aboratory experiments have shown that electric and magnetic fields can exert an influence on biological processes. Cells naturally maintain an electric charge across their membranes that is essential to the normal functioning of human tissues. In cell cultures, exposure to electromagnetic fields can affect the flow of chemicals across membranes, interfere with synthesis of genetic material, alter the activity of hormones and other chemicals, and change the behavior of cancer cells. Studies with mice show disruptions in eating, breathing and sleeping patterns. An experiment with human volunteers who were exposed to electromagnetic fields found they experienced a reduced heart rate and modified brain waves.

But all the studies so far have merely raised more questions. For example, How exactly do electromagnetic fields produce

the alterations in cells? Are the changes temporary or permanent? Do they reflect normal adjustment or a harmful effect? Equally mystifying is what kind of exposure might constitute a danger. Is five minutes in a high-intensity field worse than 24 hours in a weak field? Says Imre Gyuk, manager of the electromagnetic program at the Department of Energy: "We don't at present have a scientific basis for regulatory action."

To resolve the issue, new studies are under way. If they show that electric power is harmful, the effect could be devastating. Appliances and electronic equipment would have to be redesigned, many homes rewired and the nation's power-distribution system overhauled. Lawsuits, already on the rise, would surge as citizens filed claims to cover illness or property devaluation.

Faced with the present uncertainty, what should a person do? Home buyers might want to consider whether electrical cables are near a desired property, but experts do not advise people to sell their homes to escape being close to power lines. Instead, some easy, inexpensive changes make sense. Among them: use electric blankets only to warm beds before retiring, place the electric alarm clock across the room instead of by the bed and sit at least ten feet away from the television set. Above all, avoid excessive worrying. Until the verdict is in, the watchword is prudence, not panic. —By Anastasia Toulfexis. Reported by Bruce van Voorst/Washington, with other bureaus

# SOURCES OF MAGNETIC FIELD EXPOSURE

